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POWER AND THE ENGINEER

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Vol. 29. Index to Advertisers and Classified Index Following Reading Matter No. 11.

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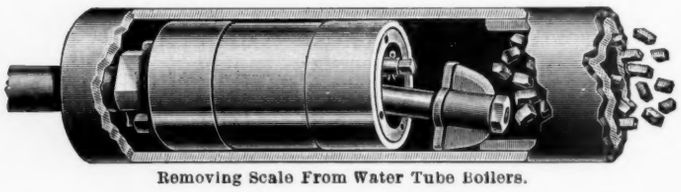
In the first place, it is the only cleaner that removes both soot and scale in the same operation.

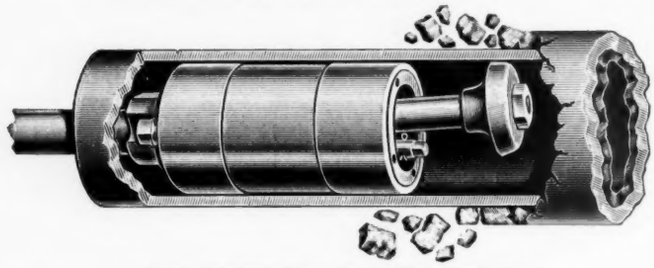
It is the only cleaner that cleans with equal thoroughness the tubes of both water tube and return tubular boilers.

The reason for this is simple enough: It removes scale by vibration; the same vibration that jars off the scale from one side of the tube dislodges the soot from the other. Then, by changing the vibrator or hammer, you may have a water tube or fire tube cleaner, as you desire.

In the second place, it can be used with equal safety in thin copper condenser tubes and heavy iron tubes *because the force of its blow can be regulated—made lighter or heavier without any regard to the steam or air pressure employed.*



Removing Scale From Water Tube Boilers.



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Finally, the Dean can be equipped to permit of operation in two or more different sizes of tubes.

There is no scale too heavy or tenacious for the Dean to remove. It cleans 10 to 30 tubes an hour. It leaves the tubes as clean as a gun barrel.

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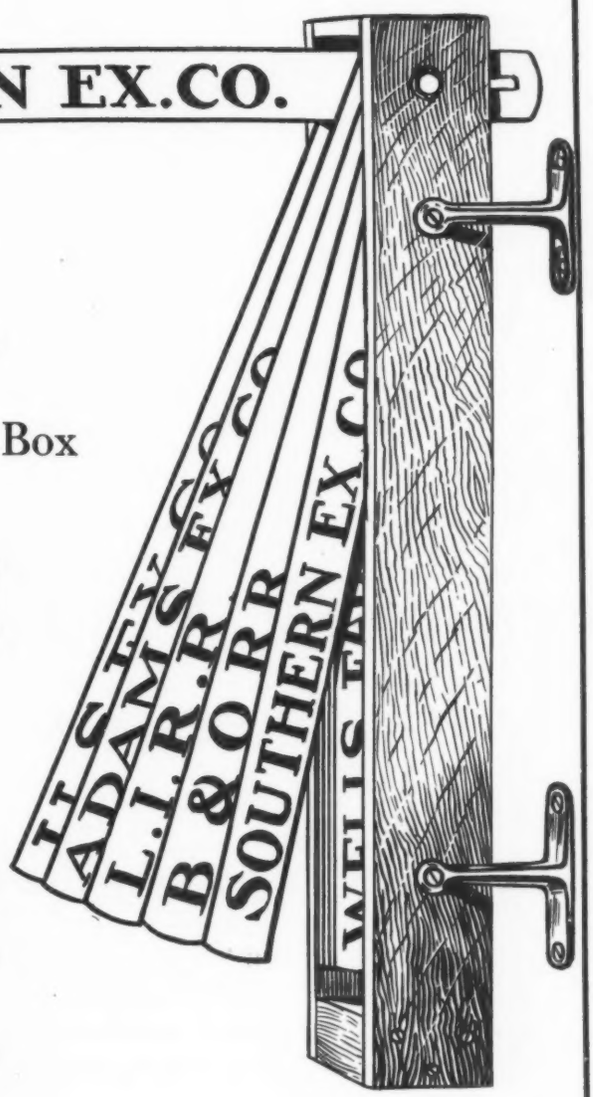

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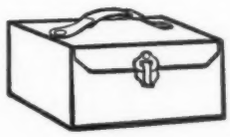

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Its width.....
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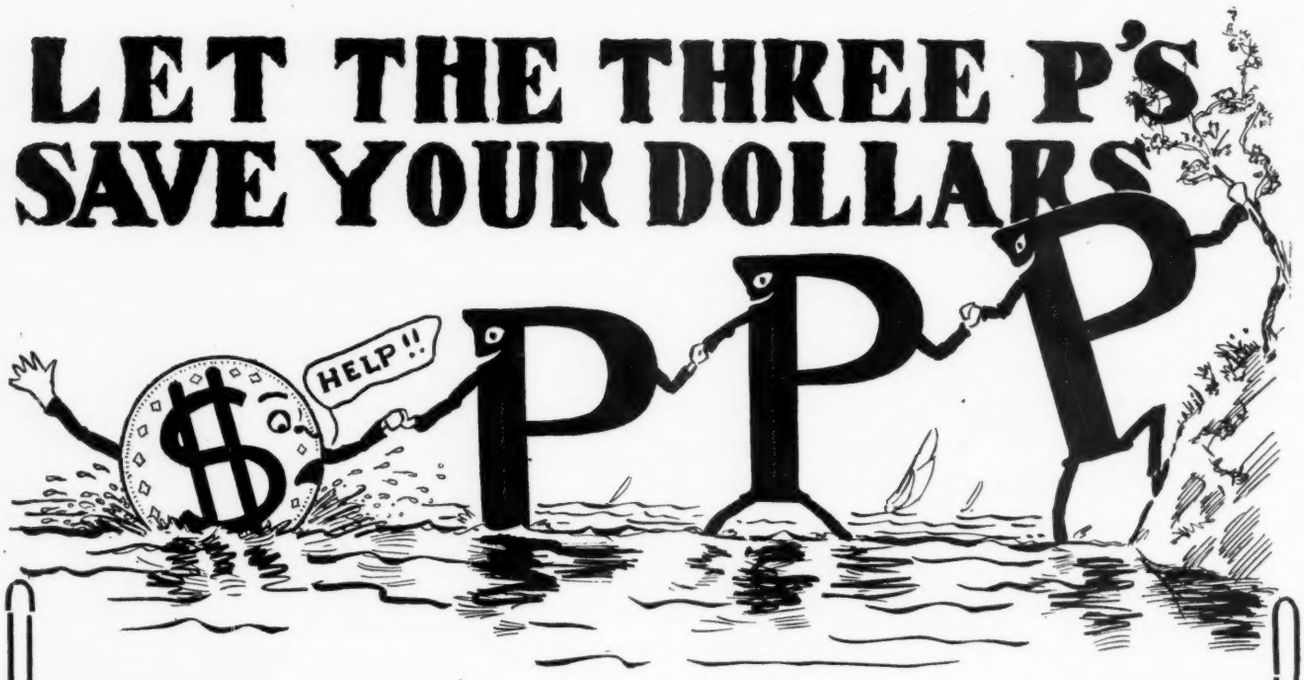

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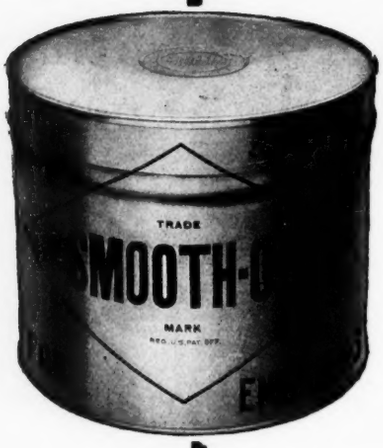
A Power Plant Necessity---



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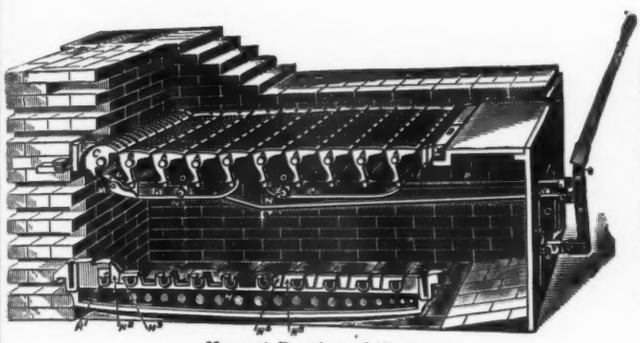
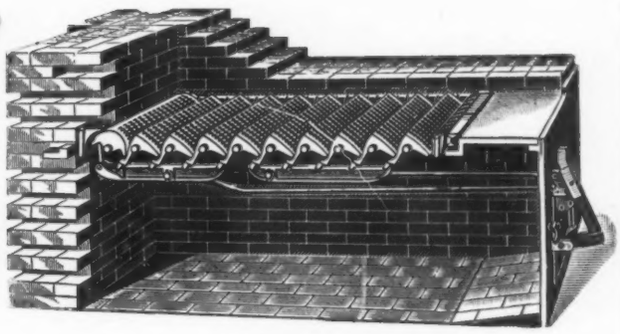


Normal Position of Grate



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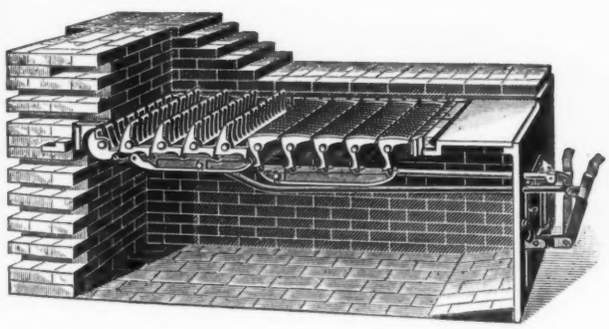
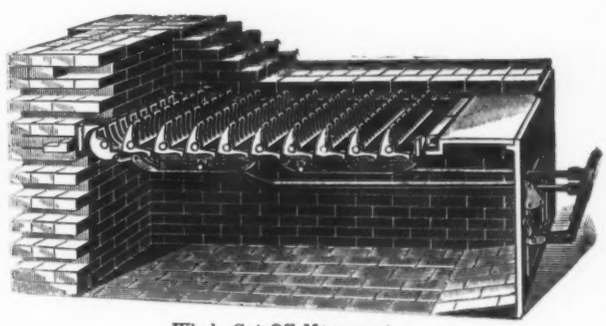
McClave Grate presents a fire surface especially adapted to prevent the waste of fine, unconsumed fuel. It's shaking motion does not increase the size of the openings.

The Argand Blower furnishes a large volume of air thoroughly mixed with steam and delivers it with very little noise.

This grate and blower combined reduce fuel cost to the lowest possible terms while actually increasing the steaming efficiency of the plant.



Divided Cut-Off



Whole Cut-Off Movement

Argand Steam Blower

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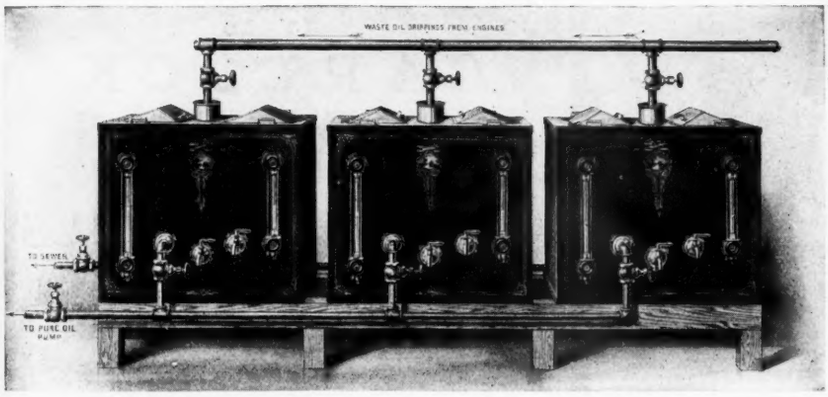
The Burt Unit System of Oil Filtration



Three "Units" connected and operated as one filter.

allows for unlimited expansion to take care of any amount of oil used. Units may be added at any time, and the capacity of the system is increased 200 to 250 gallons per 24 hours by each such addition. Unit filters save drip oil, by a process of filtering, washing and cleansing, and return it absolutely pure. Thus your oil can be used over and over again, and 50 to 75% of your oil bills is saved. The U. S. Steel Corp. have recently sent us their 8th order calling for 13 units.

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Largest Manufacturers of Oil Filters in the World.

Burt Exhaust Heads for Condensation

give certain protection to roofs, walls and side-walks by separating every bit of condensation water and oil from exhaust steam. They are stronger and more durable than any others as they have malleable iron bases and drips (galvanized). All seams and attachments are perfectly water tight. The "Burt" returns the condensation to the boiler and also acts as an efficient muffler for the exhaust pipe.

The Baldwin Locomotive Works have 55 Burt Exhaust Heads in use at the present time and the Pullman Company 33.

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The Burt Mfg. Company,

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Also Supplied by Engine Builders, Dealers and Power Contractors.

Pacific Light and Power Company's Plant

A Modern Steam Power Central Station Just Completed at Redondo, Cal., in Which Reciprocating Engines Were Adopted as Prime Movers

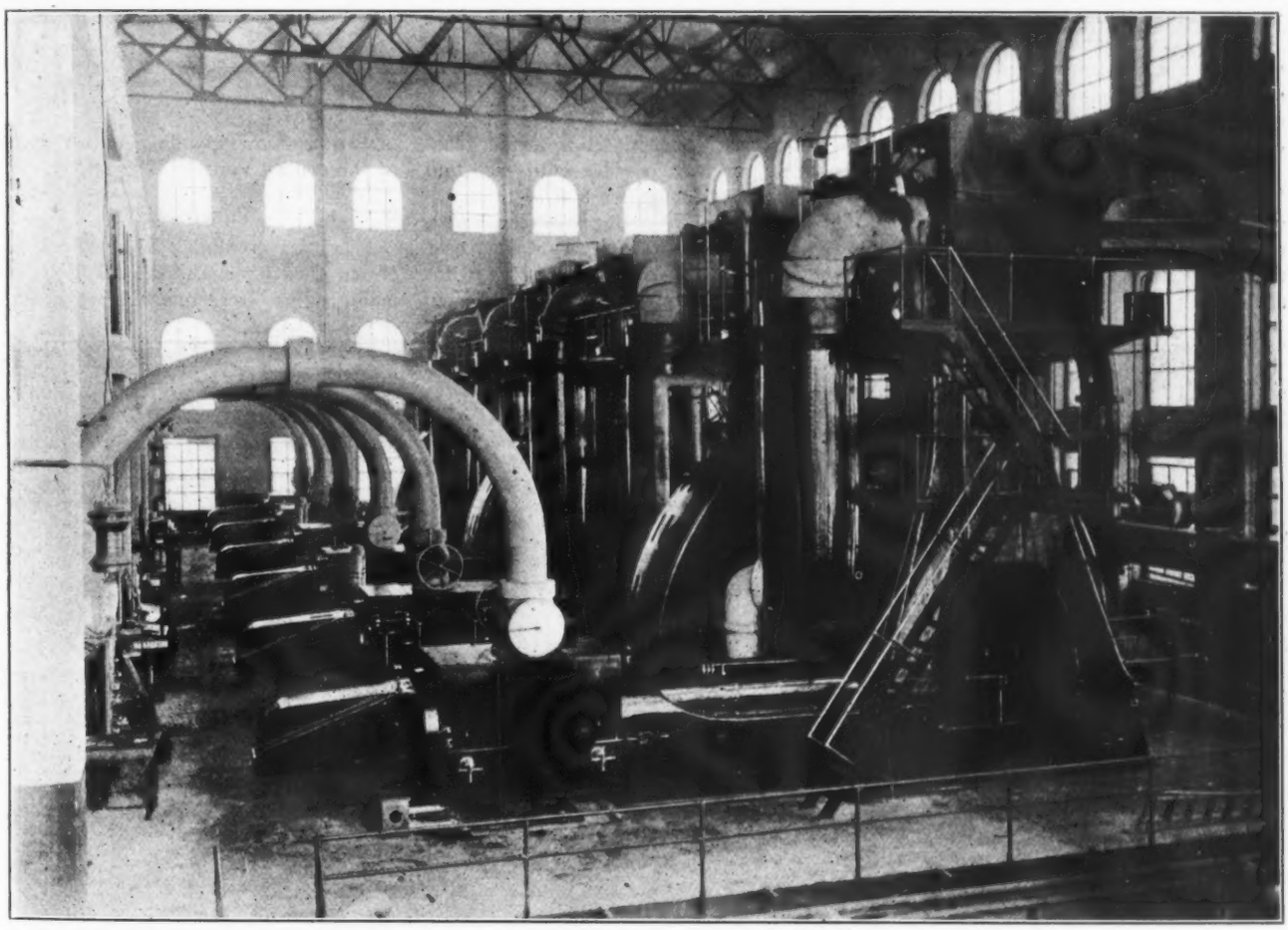
A most interesting example of recent steam power-plant design is the station of the Pacific Light and Power Company, at Redondo, California. Possibly the feature which will first attract the attention of Eastern central-station engineers is the adoption of reciprocating engines in preference to steam turbines for the prime movers. It is interesting in this connection to note that the first cost of this plant has not exceeded by 5 per cent. that of a turbine station.

Considerably at variance with the customary method of procedure with large plants, the purchasers, desiring to secure the most reliable and economical steam-power plant possible, intrusted the design of this station to a firm of contracting engineers with which was placed a fixed-sum contract for the entire installation. As customary guarantees for water consumption of prime movers, efficiencies of boilers and various auxiliaries under ideal conditions were considered of no protection under commercial conditions of variable load, a definite complete plant economy was guaranteed, based on a commercial railway load, subject to penalty and bonus stipulations.

A further feature of interest was the stipulation in the contract that the plant be started and operated by the contractor for a period of at least three months prior to the economy test, also during the test, in order to organize the operating crew thoroughly and perfect the adjustment of the apparatus.

The test to determine the economy of the plant was to have been of ninety days' duration on one unit operating on a commercial railway load. Inasmuch as the plant had been operated regularly more than six months previous to the test, it was considered that the endurance run was unnecessary and the test period was, therefore, reduced from ninety to fifteen days. As a result of the test, which was probably the most elaborate power-plant test ever undertaken, the committee in charge has reported an actual economy, under commercial load, which has not only earned for the contractors the largest amount of money ever paid as a bonus on a steam-power plant guarantee, but has also exceeded the economy of any central station of published record.

The contract for this station was placed with Charles C. Moore & Co., of San Francisco, and the plant has a nominal capacity of 15,000 kilowatts, there being three units of 5000 kilowatts each; the contract covered the entire plant installation, including machinery founda-

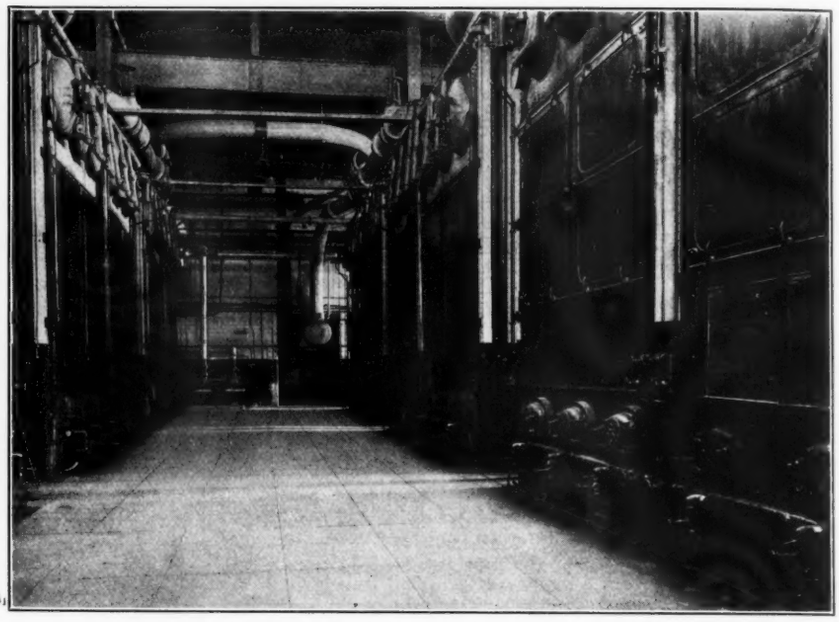


VIEW OF ENGINE ROOM OF PACIFIC LIGHT AND POWER COMPANY'S STATION

tions, excepting the switchboard, building, circulating water-pipe line, wharf and any other work outside of the building, and the plant, within the contract limits, was designed by C. R. Weymouth, chief of the engineering department of Charles C. Moore & Co.

The Pacific Light and Power Company is engaged in both lighting and power supply, but the greater part of the output of this station is used for operating the railways of Los Angeles and suburban towns, including all of the well known Huntington system of interurban railroads. In order to obtain an ample supply of water for condensing purposes, the plant was located at Redondo, a beach town eighteen miles southwest of Los Angeles. The fuel situation is ideal. Crude oil is obtained from wells near the plant, in which the company is largely interested. Owing to the system of oil firing in use, the boiler-room labor cost is low. Consideration of these facts in connection with the remarkable economy attained warrants the statement that this plant is developing steam power at a cost probably lower than that of any other large American central station.

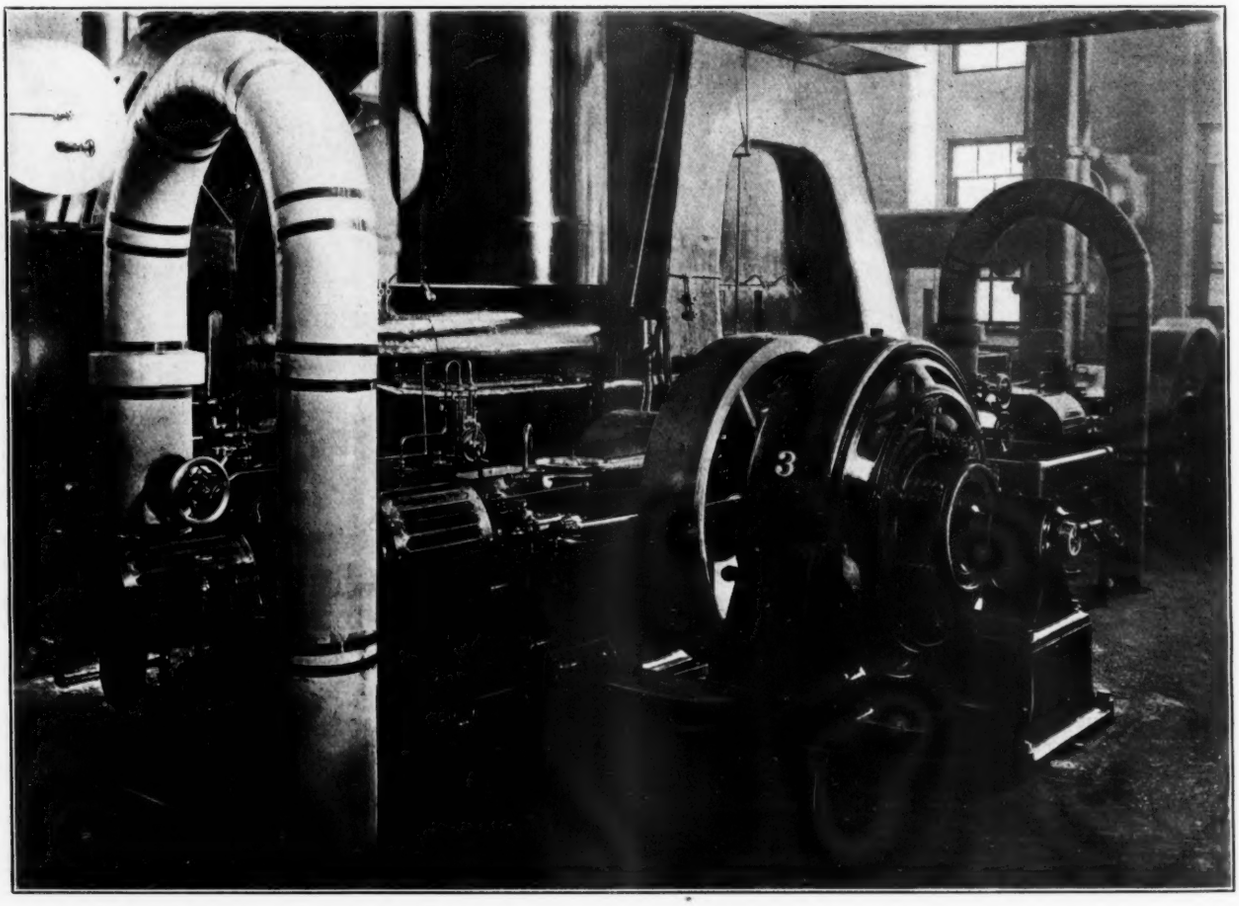
The panel system of design was followed, as will be noted from the accompanying drawings. Owing to the fact that each main engine consists in reality of two compound engines connected to one shaft, each having its independent steam and exhaust connections, a further subdivision has been possible with each unit in the connection of one-half of the panel of boilers to each high-pressure cylinder, and the provision of a separate condenser and air pump for each low-pressure cylinder, giving in effect the freedom from breakdown corresponding to six instead of three plant units.



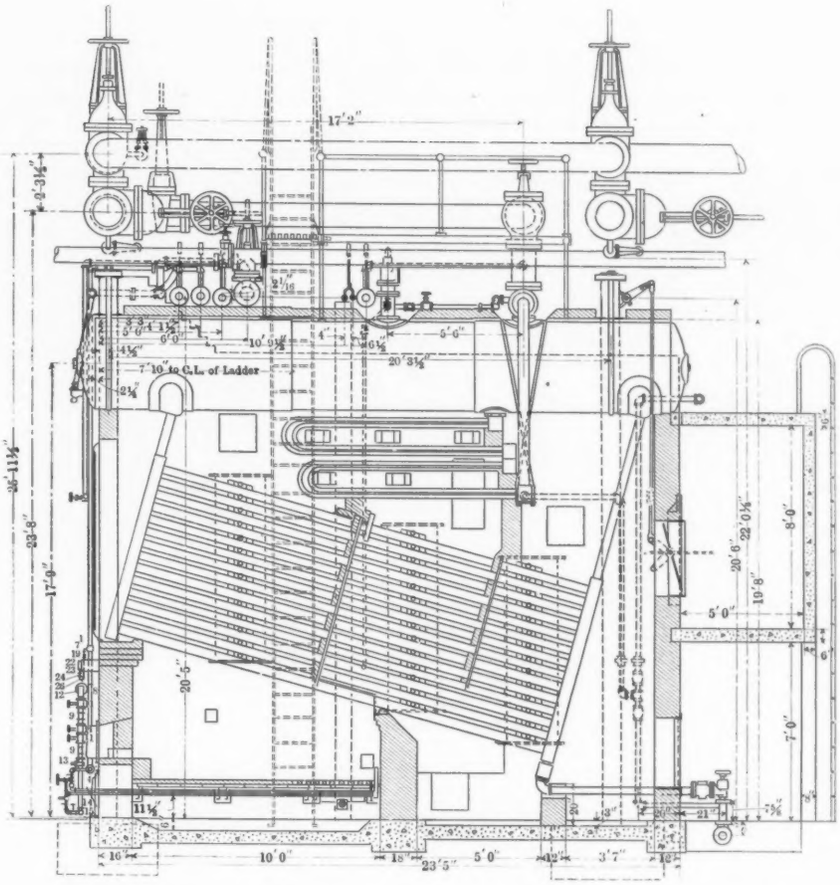
FIRING ALLEY BETWEEN BOILER PANELS

The Boilers

There are six Babcock & Wilcox boilers in each panel corresponding to each main engine, five boilers being operated



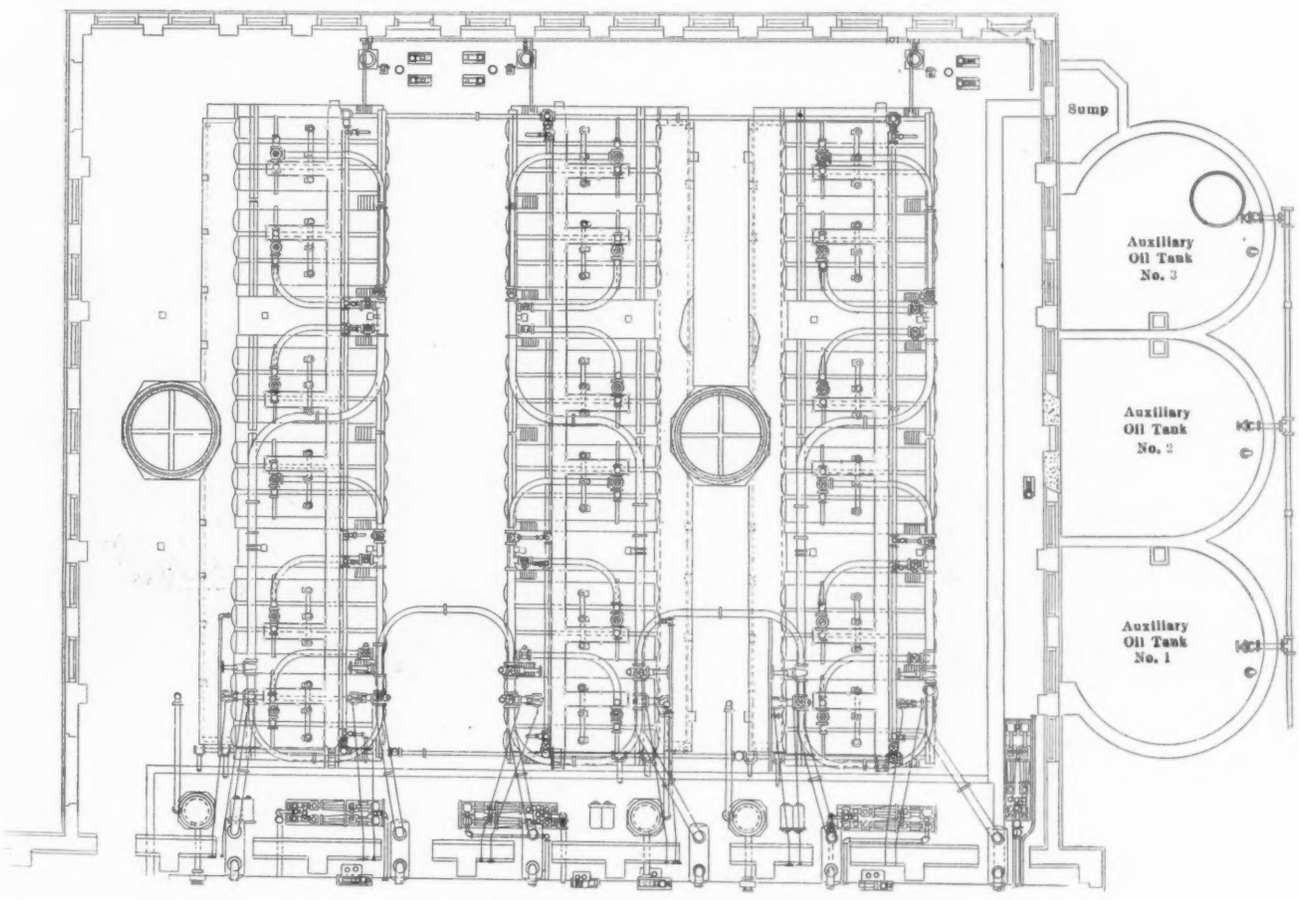
SHOWING THE NO. 3 HARRISBURG EXCITER ENGINE



SECTIONAL ELEVATION OF BOILER, SHOWING OIL FURNACE, SUPERHEATER, ETC.

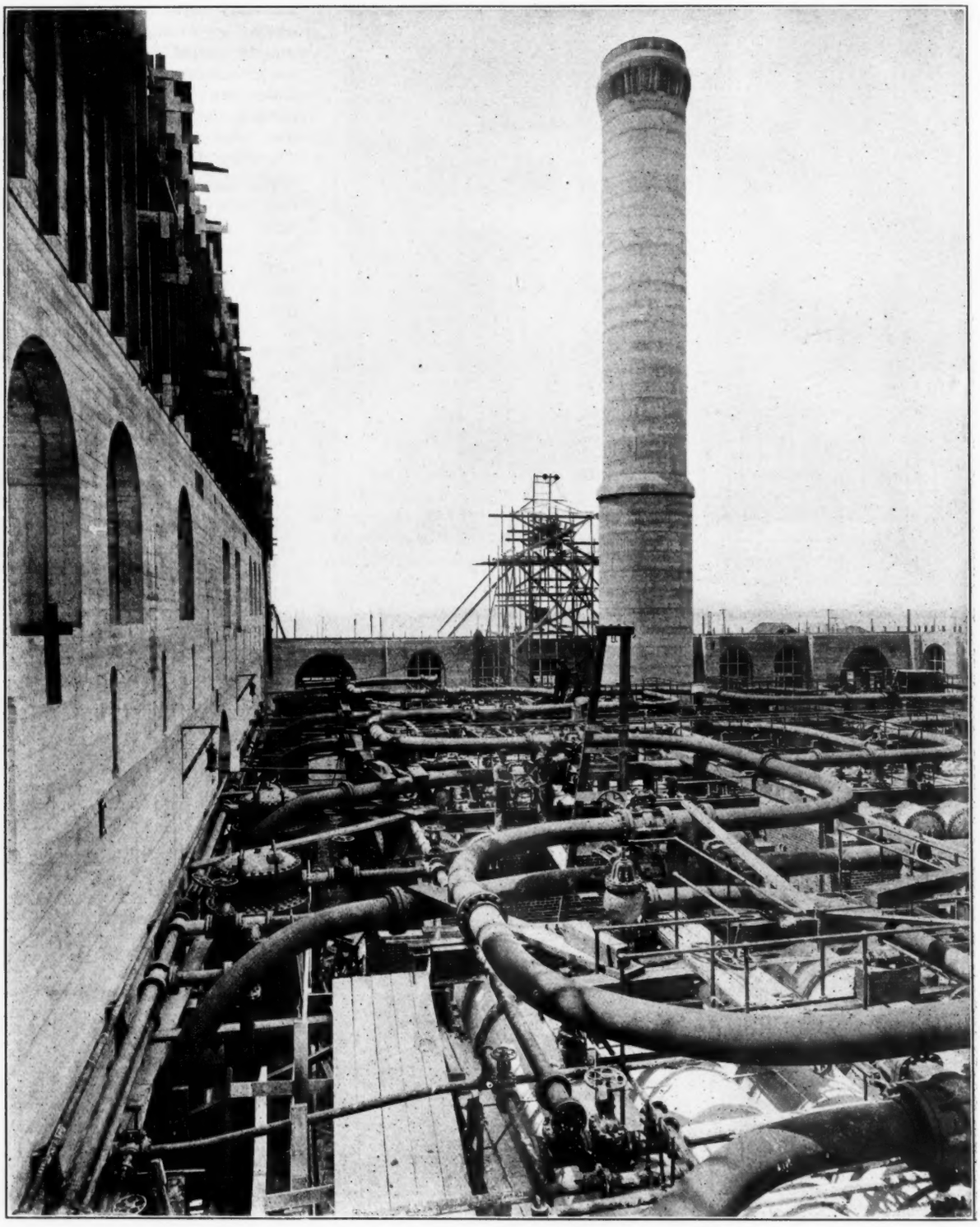
on the normal load and one being kept in reserve. The waste gases from the boiler furnaces discharge through short reinforced concrete flues to centrally situated chimneys of reinforced concrete. A novel feature of the boiler plant is the use of secondary tight-fitting sliding dampers, which are completely closed during standby period, to cut down fuel loss due to circulation of cold air through the boiler setting. Peabody oil-burning furnaces are used and the oil is supplied to the burners by steam-driven pumps. There are three burners to each boiler.

The eighteen boilers are arranged in nine batteries of two boilers, three batteries comprising one "panel." Each boiler contains twenty-one sections, each section having fourteen tubes 4 inches in diameter and 18 feet long. There are three steam and water drums 42 inches in diameter. The total effective water-heating surface per boiler is 6042 square feet. The boilers are designed for 200 pounds working steam pressure, and the pressure at the engine throttles is 175 pounds gage. Each boiler is equipped with one Babcock & Wilcox forged-steel superheater, designed to give approximately 100 degrees Fahrenheit superheat at the boiler nozzle. This superheat can be slightly increased or decreased at will by the arrangement of baffling over the first pass. The superheat at the engine throttles is 80 to 90 degrees.



PLAN OF BOILER ROOM, PACIFIC LIGHT AND POWER COMPANY'S STATION

There are two reinforced-concrete chimneys, each 13 feet in diameter and 125 feet high. The flue gases pass from the boilers to the chimneys through reinforced concrete flues; these have proved highly satisfactory, although slight heat cracks have developed in several places.



VIEW OF BOILER-ROOM PIPING DURING ERECTION

The Engines

There are three McIntosh & Seymour compound condensing engines, each unit comprising one vertical and one horizontal cylinder and the same arrangement of low-pressure cylinders. As usual with this make, a superheating receiver is provided between the high-pressure and low-pressure cylinder of each unit, superheated steam being supplied to the heating coils at boiler pressure. The condensation from these coils is almost as hot as the water in the boilers. The engines are 34 and 70 inches bore by 56 inches stroke, and are equipped with the standard McIntosh & Seymour gridiron valves and valve gear, except that the governor, which is also the standard type used by the builders, controls the point of cutoff through auxiliary valves on both high-pressure and low-pressure cylinders, the main admission valves having fixed travel. The governor is equipped with a delaying dash pot for facilitating parallel operation. The dash pot retards the gov-

ernor weights for a small fraction of a second, thereby preventing any oscillation of two or more units from becoming amplified.

Each engine is also fitted with an electrically operated speed-changing mechanism applied to the governor; this is operated by a small motor which is controlled from the switchboard gallery. This arrangement allows the engine to be speeded up or down four or five revolutions while running, to bring the generator into synchronism, and is also used to divide the load between engines.

Metallic packing is used on all piston rods and valve rods. The engine cylinders are supplied with oil by force-feed oil pumps.

Previous to acceptance of the plant a demonstration was made which showed that a unit could be successfully operated with one, two or three of the four cylinders; also with one end of any cylinder out of commission.

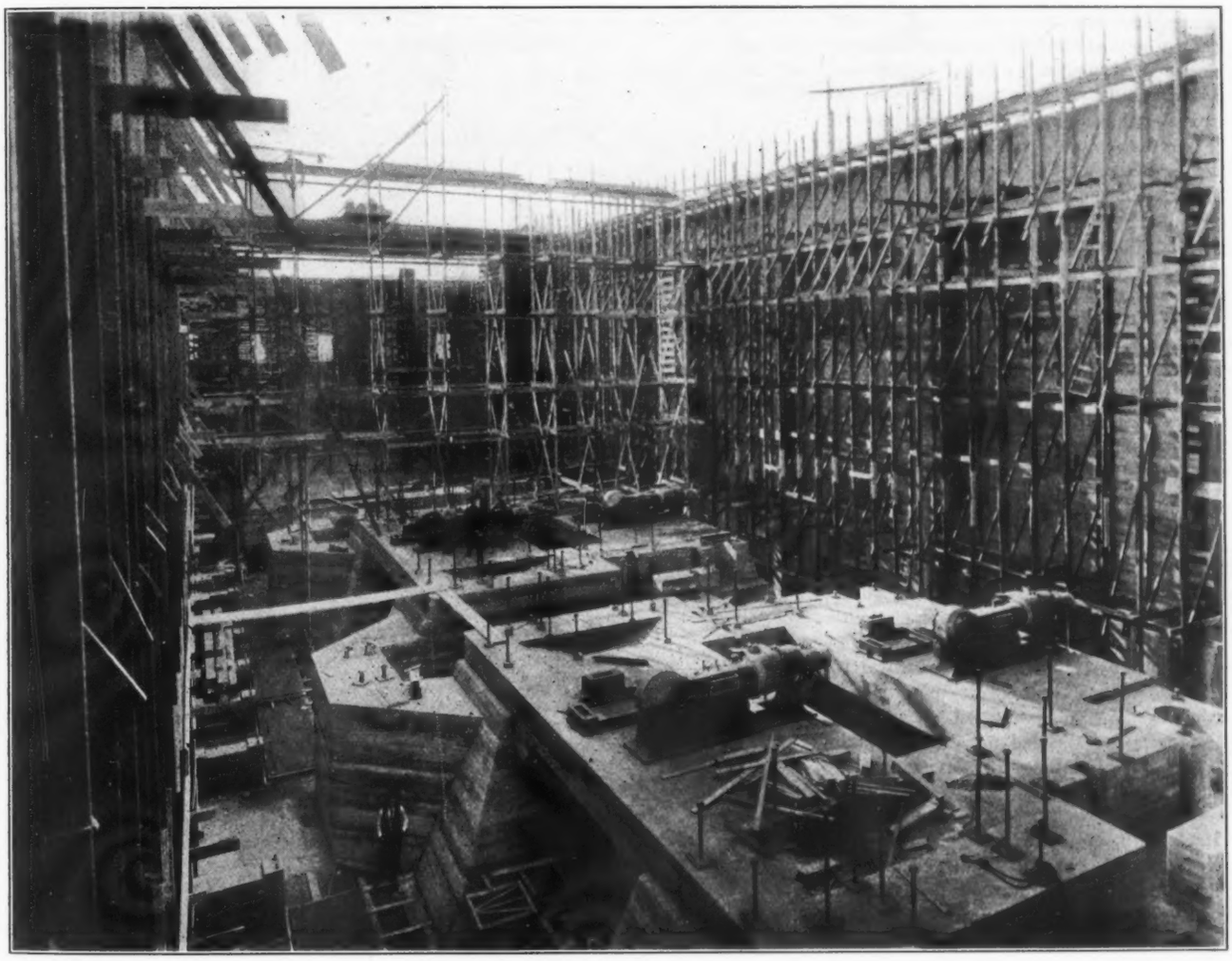
The main engine bearings and guides are provided with water jackets for cooling, and fresh water is circulated through the jackets by small pumps. The discharge water from the jackets is cooled by means of a small surface condenser; the fresh water for cooling the bearings flows within the tubes and salt water is circulated around the tubes, being taken from condensing-water suction mains.

The Condensing Equipment

The plant contains six Wheeler "Admiralty" surface condensers, one being connected directly to each low-pressure cylinder of each main engine. Each condenser contains 5200 square feet of cooling surface; the tubes are of brass, ¾ inch outside diameter, with walls No. 18 B.W.G. in thickness. In addition to the regular cooling surface of each condenser, there is provided in the upper compartment a series of tubes comprising what is termed a Volz heater. After being discharged from the air pump the condensed water passes through this heater under atmospheric pressure and is heated to within a few degrees of the temperature of the exhaust steam surrounding the heater tubes. The make-up water is also brought in at this point, securing the benefit of heat which would otherwise be wasted.

The provision of two condensers on each unit, with cross-connected exhaust passages, is a convenient feature. Should it become necessary for one condenser to be cut out of service, the exhaust steam from both low-pressure cylinders may be led to the remaining condenser, making non-condensing operation unnecessary except for a failure of circulating water or the breakdown of both condensers at one time. Actual operation shows but a slight falling off in vacuum due to this doubling of the load on one condenser. Eliminating air leaks in exhaust pipes and minimizing the loss of vacuum due to pipe turns has been given very careful consideration in all its details, the vacuum joints being as carefully made as in high-pressure steam piping. In regular operation with ample water at 70 degrees Fahrenheit a vacuum of from 28 to 28½ inches is easily maintained.

Each condenser is provided with an Edwards triplex suction valveless air pump, motor driven. Each air pump discharges into a vertical stand pipe to eliminate entrained air, after which the water subsequently used as boiler feed passes through the Volz heater in the upper portion of the condenser shell, as previously mentioned. Each of the Edwards pumps has cylinders 16 inches in diameter with 10 inches stroke. The condensed steam and non-condensable vapors



VIEW OF ENGINE FOUNDATIONS

flow continuously by gravity from the condenser to the base of the pump and are removed by the conical bucket or piston peculiar to this pump. The pump is driven by a 25-horsepower General Electric induction motor mounted on an extended base and geared to the pump through a rawhide pinion; only one-fifth of the rated power of the motor is required during normal conditions of load. The motors receive current from the generator of the unit to which they belong; consequently, the air pumps start up gradually and automatically with the main engine.

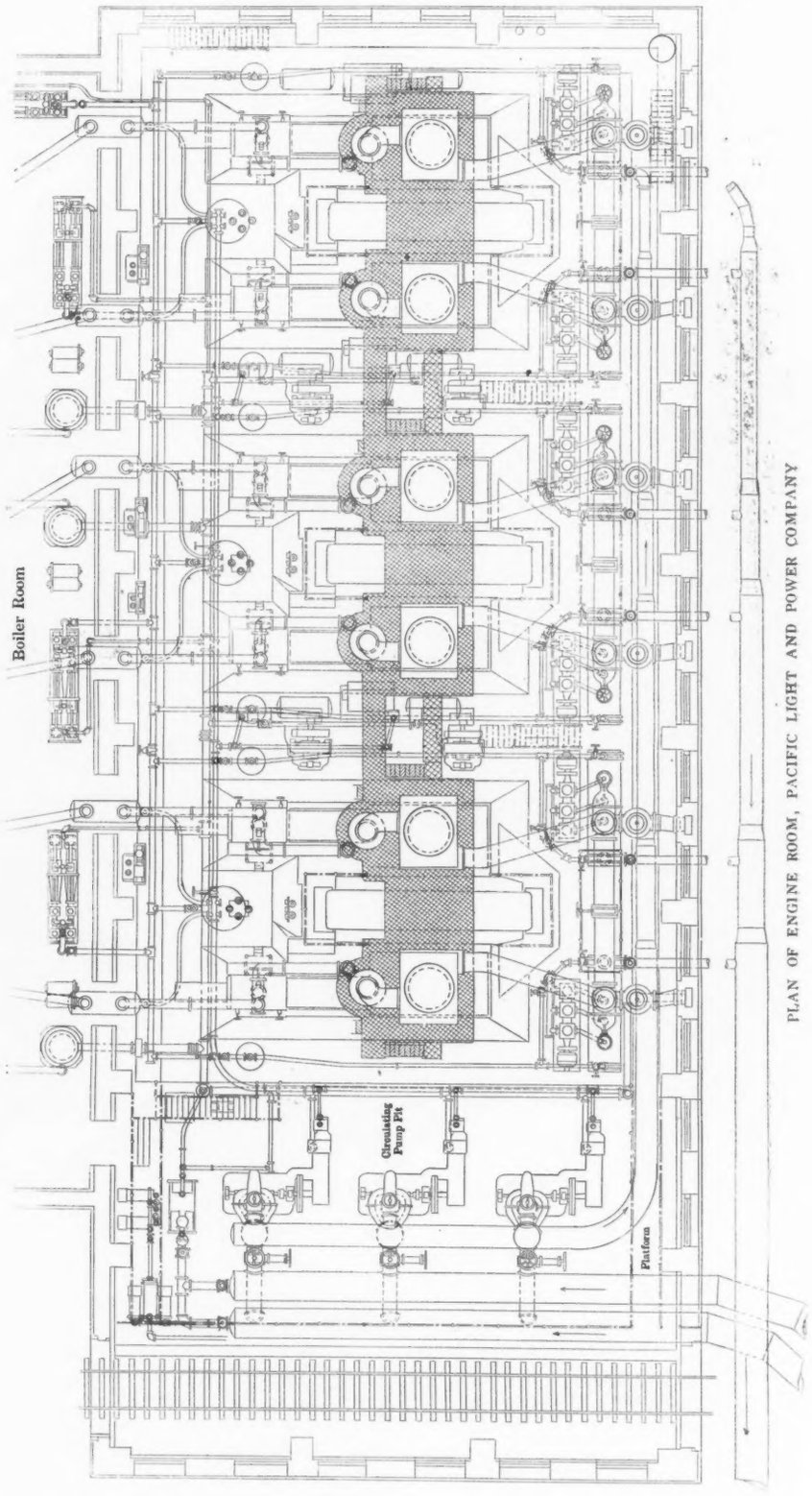
A siphon system of suction and discharge pipes for circulating water was adopted by reason of the location of plant, the use of a conduit or canal system being impossible. There are two 50-inch suction mains and one discharge line of the same size, supported on a pile wharf carried out to deep water at low tide. The suction pipes are primed by means of a large motor-driven vacuum pump operating through a 40-foot standpipe, which prevents the carrying of water into the vacuum-pump cylinders. When once started, suction is maintained by three engine-driven centrifugal circulating pumps, located in the pump pit, there being one pump for each unit. Each pump has separate connections to both suction lines and all pumps discharge into a common supply main having inlet connections to all condensers; all condenser outlets are connected to one return main. The flexibility of this arrangement is apparent. Any pump may be used to supply any set of condensers; although when two or more pumps are running their operation is necessarily in parallel. The regulation of relative amounts of water through various condensers is accomplished by the condenser discharge valves; the engines are speeded up or down and the number of engines in service is increased or decreased as load conditions require.

Each of the circulating pumps has a 20-inch discharge and two 15-inch suctions. Each pump is provided with an outboard bearing of the ring-oiling type, and the pump and bearing are mounted on an extension of the engine base. Direct-connected to each pump there is a 9x17½x12 Harrisburg tandem compound noncondensing piston-valve engine. The limiting speed of the engine is controlled by a throttling governor, but an adjustable eccentric is provided for adjusting the point of cutoff to obtain maximum economy.

Feed-water Pumps and Heaters

That portion of the feed water for the boilers which passes through the Volz heaters in the condenser shells next passes through marine-type filters or oil separators, after which it enters the suction main of the feed pumps and is sent to the boilers through auxiliary heaters, along with the condensed exhaust from the steam-driven auxiliaries; all auxiliaries except the air pumps are driven by noncondensing steam engines.

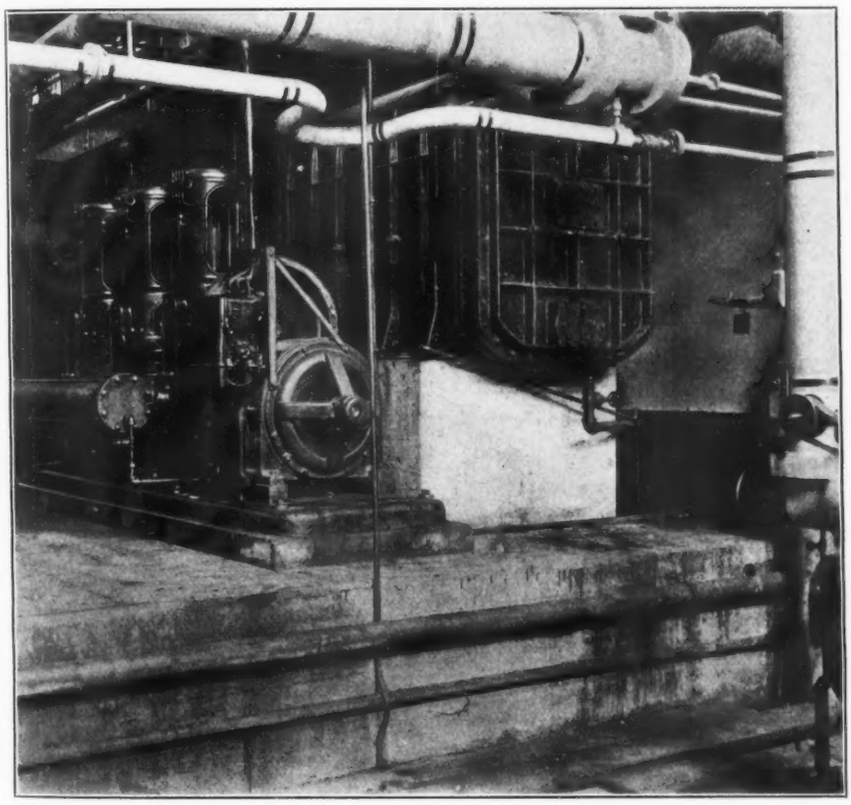
The air pump discharge is pumped through six Day filters, 48 inches in diameter and 5 feet high. Each filter has five compartments of filtering material, which eliminate the greater portion of entrained cylinder oil. The water enters in the top of the filter, passes down through the filtering material and out at the bottom to a standpipe, maintaining a complete submergence of the filtering material. Owing to the low velocity of the water through the filter, there is a tendency for any oil not absorbed by the filtering material to rise to the surface rather than to be carried on and into the boilers by the downward flow of water.



PLAN OF ENGINE ROOM, PACIFIC LIGHT AND POWER COMPANY

Entrained oil in the exhaust from the auxiliaries is so completely removed by means of Cochrane oil separators that the condensed steam drained from the body of closed Goubert heaters is as clear as drinking water.

There are four Snow duplex horizontal boiler-feed pumps, having compound steam ends, outside center-packed water ends. Each pump serves one panel of boilers, one of the four pumps being held in reserve. There are three Goubert vertical auxiliary feed-water heaters of the multiple-flow type, one for each panel of boilers. Each heater contains 1000 square feet of effective tube surface. The supply of exhaust steam is such that under practically all conditions of load all of the exhaust from the auxiliaries is utilized in these heaters.



MOTOR-DRIVEN TRIPLEX WHEELER-EDWARDS AIR PUMP AND WHEELER CONDENSER

The Fuel-oil Plant

The fuel oil is stored in large steel tanks having sufficient capacity for from 30 to 45 days' supply. The oil is pumped into auxiliary tanks outside of the building at one end of the boiler room, each tank having a capacity of 1000 barrels. The tops of the auxiliary tanks are on the same level as the boiler-room floor line to conform to the underwriters' requirements. The grade line is about 14 feet above the floor of tanks, and the surrounding earth is withheld by means of circular retaining walls. These tank pits are roofed over and properly ventilated. All pipes connecting to the tanks are controlled by valves located on the boiler-room side, there being a 3-foot concrete wall between the tank compartments and the operator. There are fire partitions between adjacent tanks and fire-proof doors connecting the tank compartments. The manhole covers in each tank are padlocked, so that it is impossible for an operator to set fire to any of the tanks.

In lieu of steam smothering pipes leading to the interior of the tank compartments, there is provided above each tank a steam ring of 4-inch pipe, having a number of jets sufficient to provide a sheet of steam which would effectually cut off any supply of air from the outside and promptly smother any fire which might be started.

As originally laid out there was provided a duplicate set of oil-feed pumps for each unit, or six oil pumps in all. So far, the plant has been operated in this way, but it is now being remodeled to have one set of pumps to supply the entire station, requiring but one pump operator instead of three on each shift.

The system of regulation employed is an automatic one invented by J. R. Atchison and C. R. Weymouth, the patents for which are controlled by Charles C. Moore & Co. The oil is pumped under pressures varying from 10 to 50 pounds, depending on load conditions, there being a uniform oil pressure throughout all portions of the plant and all burners being operated wide open or nearly so. The amount of oil burned, with variations of load, is controlled by the pressure of oil at the oil pumps, the intensity of the fire increasing and decreasing in all furnaces simultaneously. The oil pressure is automatically controlled by a steam-pressure regulator to maintain a uniform steam pressure on the plant.

Steam for atomizing the oil is supplied to the oil burners through a separate low-pressure main, the pressure in this main being automatically controlled by variations of oil pressure in the oil main. A ratio regulator is used, automatic in its action, which maintains such steam pressure in the main as is necessary to atomize the particular amount of oil burned, corresponding to any momentary oil pressure. In this particular plant it is found that the proper amount of steam for atomizing is furnished under a steam pressure equal to three times the oil pressure plus 30. This relationship will vary with the type of burner used, relative areas of burner orifices for steam and oil.

The air supply for combustion is controlled by a damper controller, also automatic in its action, which increases the damper opening with an increase in oil pressure and *vice versa*. The movement of the controlling lever is due to the oil pressure acting on a diaphragm; this movement is opposed by the action of a spring so that the movement of the main lever is proportional to the oil pressure. This movement is multiplied through a hydraulic cylinder connecting to a rock shaft running over all of the boilers in one panel. Each boiler damper is connected to this shaft, and the connecting levers are set at such angularity with respect to the connecting rods operating the dampers as to give the maximum air supply for the various ranges of loads, the final adjustment being made by actual trial at the plant.

A detailed description of this system of automatic regulation for oil firing will probably be made the subject of a special article in a future issue.

The Piping System

The general arrangement of main steam piping is shown by the accompanying drawings. All of the piping of the plant except for some of the minor auxiliaries is arranged on the panel system, corresponding to the arrangement of the boilers and engines. The throttle fitting of each high-pressure cylinder of each engine is for 14-inch pipe, and owing to the necessity for long radius bends and the desire for flexibility, it was determined not to use any steam pipes larger than that diameter. It was finally decided to connect three boilers in each panel to each member of each double unit, thereby providing greater flexibility of service without increasing the size of the pipes in the system. So far as the main steam piping is concerned, therefore, the plant can be considered in effect to consist of six independent sections.

The main steam piping was anchored to the building walls and building columns located with this idea in view. It

was found, however, that the columns were not sufficiently rigid for anchorage purposes, and it became necessary to install a cross system of bracing from wall to wall. Drainage is afforded by locating a large receiver drum in each line of piping, as shown in the drawing. For all high-pressure steam piping of 5 inches diameter and over, upset lapped joints were used, with rolled-steel flanges, forming a modification of the Van Stone joint. The bolting and thickness of the flanges were very conservatively designed in order to prevent leakage.

As only a moderate degree of superheat is required, the valves and fittings are of semi-steel, have bronze mountings, and Detroit-Edison necks to prevent the leakage of steam around the valve spindles, etc. Chapman valves are used throughout the plant.

Special consideration was given to the design of the exhaust piping in order to obtain the most direct course from the engine to the condenser. As will be noted from the cut, there is but one bend between the engine-exhaust outlet and the condenser inlet, and this is of very long radius. The exhaust pipes were made of large diameter to lower the velocity of the exhaust steam; under actual test the loss in vacuum between the condenser shell and the exhaust nozzle was at all times less than ½ inch of mercury.

All high-pressure steam piping is covered with non-conducting covering 3 inches thick, and corresponding valve body and flange covers are used throughout.

The Generators

The three main generators were manufactured by the General Electric Company. They are of particular interest on account of the unusually high electromotive force of 18,000 volts for which they are wound. These generators are rated at 5000 kilowatts; they run at 100 revolutions per minute and deliver three-phase currents at 50 cycles frequency; they are directly driven by the engines, and the field magnets are of the flywheel type, with 60 poles each. The following data may be of interest:

Floor space required	31 ft. by 6 ft. 9 in.
Diameter of stator	28 ft 6 in.
Diameter of rotor	25 ft.
Radius of gyration	8.8 ft.
Weight of stator	186,000 lb.
Weight of rotor	162,000 lb.
Weight of accessories	12,000 lb.
Total weight	360,000 lb.

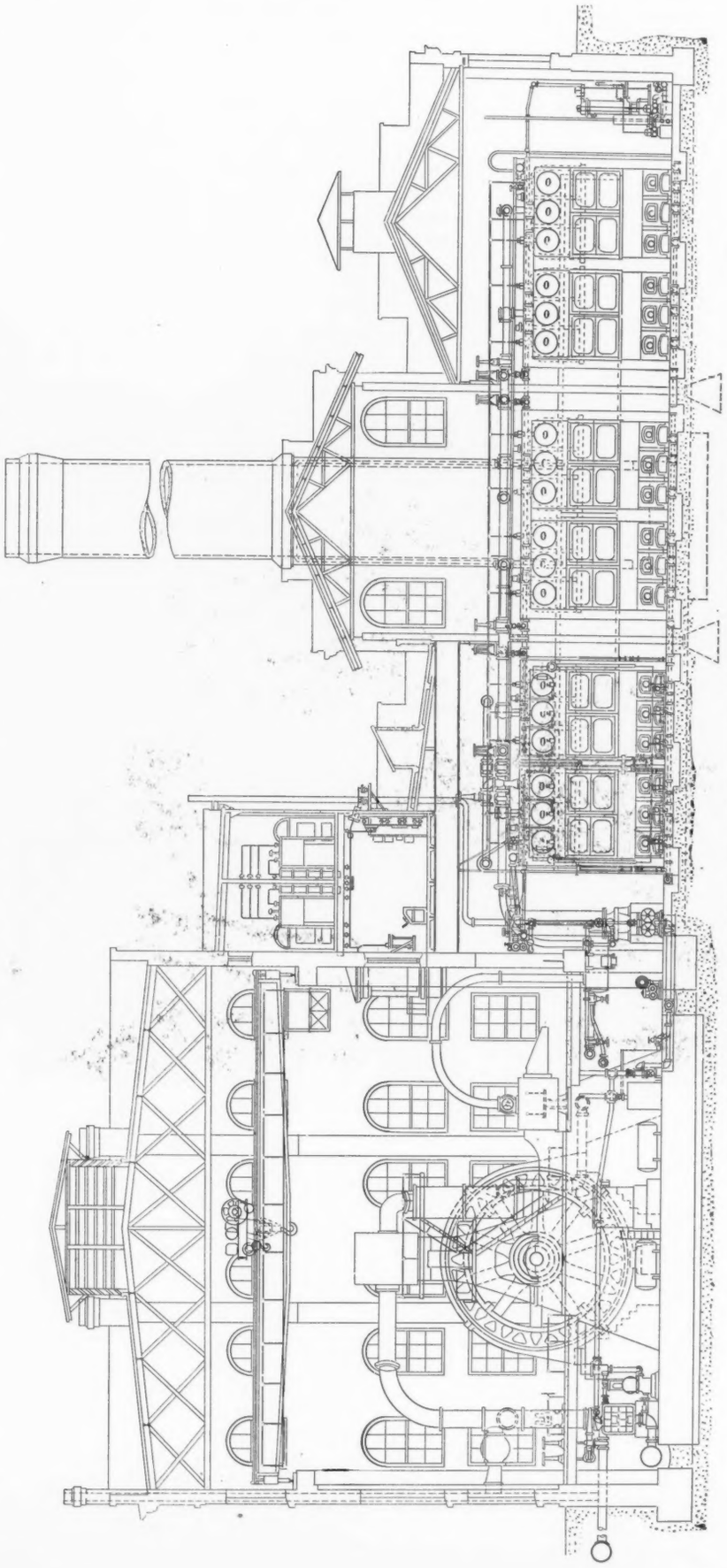
The commercial efficiencies at unity power factor are as follows:

25 per cent. overload	96.5 per cent.
Full load	96.2 " "
Three-quarter load	95.2 " "
Half load	93.5 " "
Quarter load	88.0 " "

The armature coils of these generators have stood a high-potential test of 40,000 volts for one minute.

On account of the severity of the specifications in regard to the operation of the generators in multiple with existing apparatus on the transmission system of the Pacific Light and Power Company, the field magnets are provided with squirrel-cage dampers to prevent hunting.

The contact arms of the field rheostats are motor operated, with remote control from the switchboard, and the starting,



SECTIONAL ELEVATION OF ENGINE AND BOILER ROOMS, PACIFIC LIGHT AND POWER COMPANY

stopping and loading of the various units is controlled entirely from the switchboard gallery, located above the boiler room and alongside the main engine-room wall.

Situated beside each main engine is one 75 kilowatt General Electric exciter, direct-connected to one 9 and 17 by 12-inch Harrisburg tandem compound inclosed self-oiling engine. These engines are designed for the same pressure and superheat as the main engines and operate very satisfactorily under these conditions.

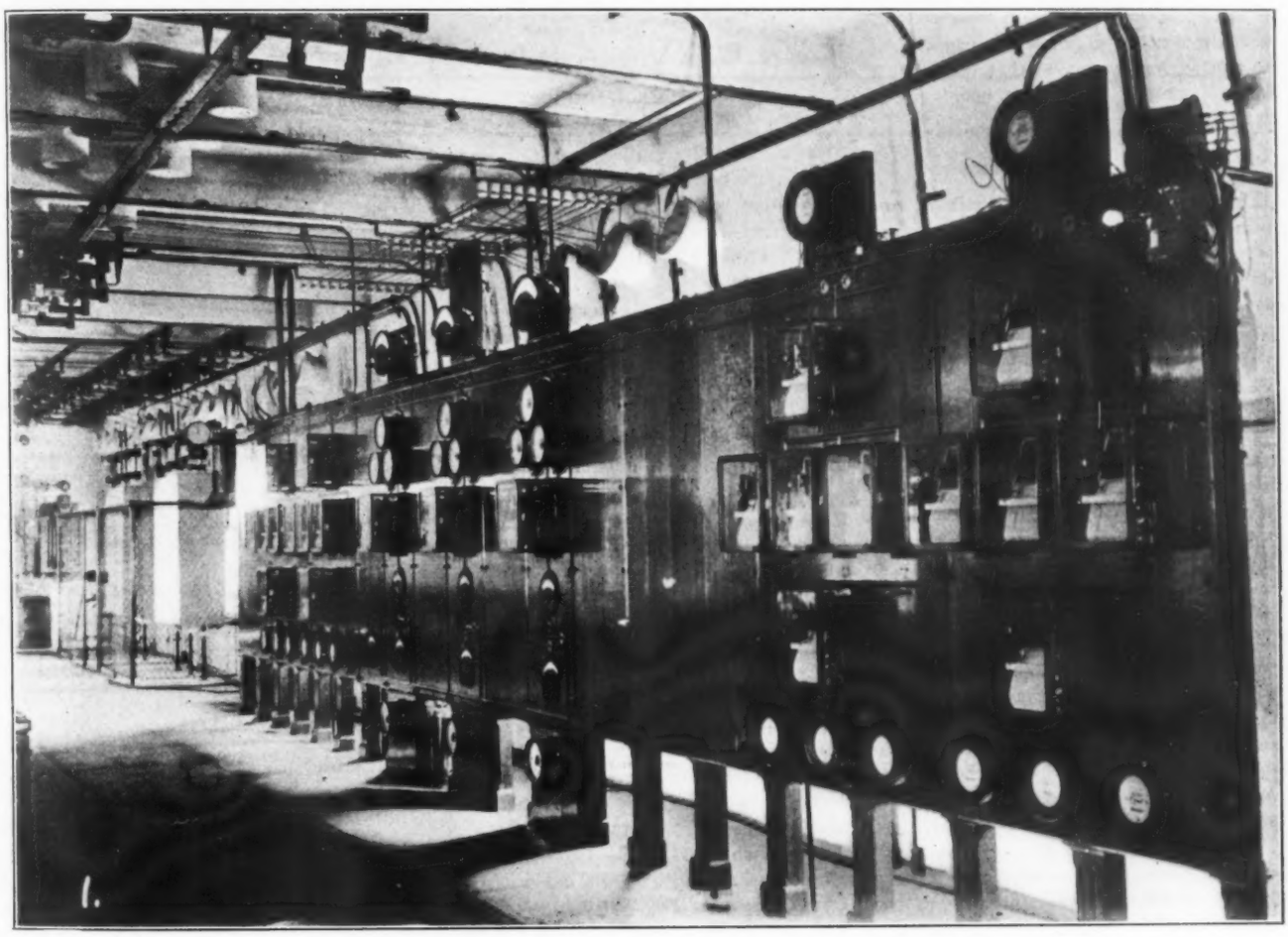
Switchboard Equipment

The following description of switchboard-gallery and station wiring was furnished by E. R. Davis, electrical engineer for the Pacific Light and Power Company.

The generator wiring between the generators and switchboard room consists of three No. 0000 bare copper wires, each in a separate duct, supported on large porcelain insulators. In addition there are one square duct and a spare cable for use in case any of the three main lines become disabled. Each generator is connected through two-way porcelain-mounted selector switches to either of two sets of high-tension busbars, which are located in two separate concrete galleries. The feeders to the two railway systems are also connected through two-way porcelain-mounted selector switches to either of two sets of high-tension busbars, in order that the men may be able to cut out and repair oil switches, insulators, etc., in either busbar gallery without interfering with the operation of the generators or the distributing feeders. The oil switches are of the single-cell, single-throw, quadruple-break type, of 400 amperes capacity per pole, mechanically connected together in gangs of three poles. These switches are operated by remote control, and the entire equipment was built in the shops of the Pacific Light and Power Company.

The operating stand and the instrument boards are made from well seasoned oak, the use of wooden construction being partly due to the saving in expense as compared with marble, but principally due to the fact that on account of the rapid progress in electrical practice switchboards rapidly become obsolete, and if built of marble they would be extremely expensive and difficult to replace. With reference to the danger from fire hazard in connection with wooden structure, Mr. Davis explains that the high-tension alternating-current wiring is connected to all switchboard instruments through current and potential transformers, only the low-tension wiring, which is permanently grounded, being actually carried to the board; the voltage on this wiring is about 120 volts. The alternating-current instruments used in connection with the feeders and generators on this switchboard are the Westinghouse graphic recording type. The exciters and alternator field circuits are equipped with Weston direct-current instruments.

The exciters are wired up to marble switchboards located on the main engine-room floor, the switches on those boards being operated from the gallery by means of compressed air. The wiring is so designed that under ordinary conditions each main unit has its independent exciter, but if anything should happen to any particular exciter, the spare exciter might be connected to any of the main units.



THE SWITCHBOARD, PACIFIC LIGHT AND POWER COMPANY'S PLANT

The operating room and galleries consist entirely of reinforced concrete construction and are in every detail entirely fireproof.

Operation of the Plant

Various practical difficulties were met with in starting the plant, as would naturally be expected in any installation of large size. The entire crew were inexperienced in the handling of machinery of more than one-quarter the size of that in this station. The task of breaking in the crew and the adjustment of the apparatus were entirely under the direction of J. R.

Atchison, superintendent of construction for Charles C. Moore & Co., under whose charge the installation work also proceeded.

One of the problems yet to be solved at this plant is the elimination from the circulating water of sea weed and fine sea moss, which foul the condensers and frequently cause loss of vacuum, compelling non-condensing operation. It is impracticable to handle these weeds and mosses with any known type of inclosed strainer.

The circulating water system was designed to operate on the siphon system, requiring a nominal head of from 15 to 20 feet on the pumps. This head at times of accumulation of sea weed rises to 35 feet and more. Even with the quantity of auxiliary exhaust steam due to this head, the amount is below the capacity of the feed-water heater, so that no exhaust steam is wasted under any usual condition of running.

Guarantee and Performance

The contract covering this station embodied an economy guarantee providing for a 90-day test of one unit on a commercial railway load, under any load curve within the limits of the rated capacity of the generator, the total output being not less than 60,000 kilowatt-hours nor more than 78,000 kilowatt-hours per 19½ hours running, there being 4½ hours standby each day. On this load the contractors guaranteed an economy of 170 kilowatt-hours per barrel of oil, each barrel weighing 334 pounds, and each pound containing 18,500 B.t.u. (36,347 B.t.u. per kilowatt-hour). The contract provision for a 90 days' test was subsequently modified to cover a period of 15 days, as explained in the beginning of this article.

To determine the economy of the plant the contracting parties each appointed a representative, the two jointly selecting a neutral member. The Pacific Light and Power Company was represented by Edward S. Cobb, its chief engineer; the representative for Charles C. Moore & Co. was C. R. Weymouth, and the neutral member was Prof. C. L. Cory, dean of the College of Electrical Engineering of the University of California. There were also present as contractors' representatives Dr. D. S. Jacobus, advisory engineer for the Babcock & Wilcox Company; Harte Cook, testing engineer for McIntosh, Seymour & Co., and J. H. Lighthipe, engineer for the General Electric Company.

The committee's report gave the result of the 15 days' test as 252.84 kilowatt-hours per barrel of oil, but a slight correction in favor of the contractors is involved because of excessive sulphur and moisture content in the oil. This record eclipses all published statements of economy of large power plants operating under commercial conditions. The test result is equivalent to slightly less than 25,000 B.t.u. in the fuel per kilowatt-hour of net plant output. This test was made on a complete unit with the exception of the circulating water pump, and allowance was made for the omission, which was due to the fact that sea-weed difficulties produced a head of from 30 to 35 feet on the circulating pump instead of the normal head of 15 feet.

The bonus earned as a result of the above economy was $363,310, which is probably the largest bonus ever paid on a steam-power plant guarantee. On the basis of the local market price of crude oil, however, the fuel saving due to the gain in economy will pay the full amount of bonus in from two to three years' time, so that the bonus is a giltedge investment.

Test of West Virginia Bone Coal in a Gas Producer

A forthcoming bulletin of the United States Geological Survey will contain an exhaustive report of the tests conducted at the fuel-testing plant in St. Louis, Mo., and Norfolk, Va., on the gas producer. An interesting feature of the report will be the behavior of a certain bone coal from West Virginia in the producer. This fuel was considered of little or no value for steam-boiler work, yet showed considerable usefulness in the gas producer, developing at the engine a brake horsepower per hour for 1.65 pounds of coal.

This coal was delivered on the producer platform in lump form up to 8 or 10 inches in size. The coal crusher not being available at the time, necessitated breaking the large lumps with a hammer. The character of the fuel was rather peculiar; some of the lumps consisted almost entirely of what appeared to be a high-grade bituminous coal, others seemed to be nothing more or less than rock, heavy and hard, and when hit in the dark with a hammer numerous sparks could be readily seen. And again there were many lumps of this rock-like substance to which adhered much good coal. In the producer all of these lumps, when not too large, would burn entirely through. The fuel had no tendency to clinker or coke and worked exceedingly well, needing scarcely any poking. It contained a very high percentage of ash, about 45 per cent., thus causing the ash bed to increase in thickness very rapidly, and throughout the test this fact was not properly appreciated; consequently much of the time during the test the ash bed was too high for best results. The fact that the coal had to be broken by hand and that it was unusually hard and rock-like had a tendency to allow lumps of coal much too large to be charged into the producer. These large lumps, very high in ash, did not burn entirely through; as soon as the burning was well started, a layer of ash formed around the lump, interfering with the combustion of the remaining portion and before it had time to burn it had passed out with the ashes unconsumed.

Because of the general appearance of the coal, but little was expected of it, and the test was started with only partial load. After several hours' run, however, the results warranted full load on the engine. After 39 hours of full load the accumulation of ash in the producer caused a little trouble; the gas went down in heat value and it was necessary to reduce the load to about 9 per cent. of full load. After much grinding down of the ash bed and special care in breaking up the lumpy coal, the gas began to increase in heat value, and at the end of the test the producer was again in shape to maintain full load at the engine. The calculations for the test are based on the 50 hours taken from the time full load was carried by the engine, and for this period the gas averaged 144 B.t.u. per cubic foot, with an average load of 97 per cent. of full load.

The following is the result of the test on the West Virginia bone coal:

PROXIMATE ANALYSIS OF THE COAL.

Moisture	0.47
Volatile matter	8.43
Fixed carbon	46.96
Ash	43.74
	100.00
Sulphur	0.27

COMPOSITION OF GAS BY VOLUME.

Carbon dioxide (CO_2)	9.7
Carbon monoxide (CO)	19.5
Hydrogen (H_2)	16.6
Methane (CH_4)	1.6
Nitrogen (N_2)	52.6
	100.00
Duration of test	50 hours.
Coal consumed in producer, as fired, lb. per hour	378
B.t.u. of coal as fired	8566
Standard gas per lb. of coal consumed in producer, cu.ft	44.1
Efficiency of conversion and cleaning gas	74.1
*B.H.P. developed at engine	228.8
Coal per B.H.P.-hr. developed at engine, lb	1.65

*Based on an assumed efficiency of 85 per cent. for generator and belt.

It often pays to spend money for improvements, although improvement does not necessarily mean the spending of money. This is true whether it be referred to property, machinery or ability. The engineer should know about everything that is on the market and be able to decide intelligently of its fitness for his purpose, and if changes or additions are urged or suggested, he should know what is latest and what is best, and why it is best. If he recommends changes in methods or machines, his recommendations should be buttressed by a convincing array of arguments as nearly as unanswerable as possible. If turned down, he should not, like a quitter, "lie down," but renew the attack at a future date, resolved never to be satisfied with anything short of the best possible conditions and the best results from these conditions.

Ten 16-candle-power 3.6-watt incandescent lamps equal one mechanical horsepower.

Parallel Operation of Rotary Converters

Different Methods of Cutting In or Out Explained in a Simple, Practical Manner, with General Rules to be Observed to Secure Proper Results

BY H. R. MASON

Rotary converters, especially on high-frequency circuits, are among the most exacting class of apparatus to operate in parallel. When being cut in and out they combine nearly all the requirements of direct-current and alternating-current motors, direct- and alternating-current generators, and some special features exclusively their own. If cut in a few degrees out of step they are apt to "flash over" and their safety devices will act with amazing celerity. Cutting in or out a rotary converter in parallel with other units is an operation which must be performed by exact adherence to an unalterable schedule of moves. For converters connected as shown by Fig. 1, which may be taken as a representative diagram of connections for starting on the direct-current side, the sequence of operations for cutting in a converter is as follows:

1. See that all switches are open and all resistance in the shunt-field circuit.
2. Close the direct-current circuit-breaker.
3. Close the negative (right-hand) direct-current main switch.
4. Close the field switch.
5. Cut all resistance out of the shunt-field circuit.
6. Close the direct-current starting switch one point at a time, allowing the converter to attain maximum speed for each point before advancing to the next.
7. Close the positive (left-hand) direct-current main switch.
8. Synchronize by regulating the speed by means of the shunt-field rheostat.
9. At exact synchronism close the alternating-current oil switch which has an automatic device for tripping the di-

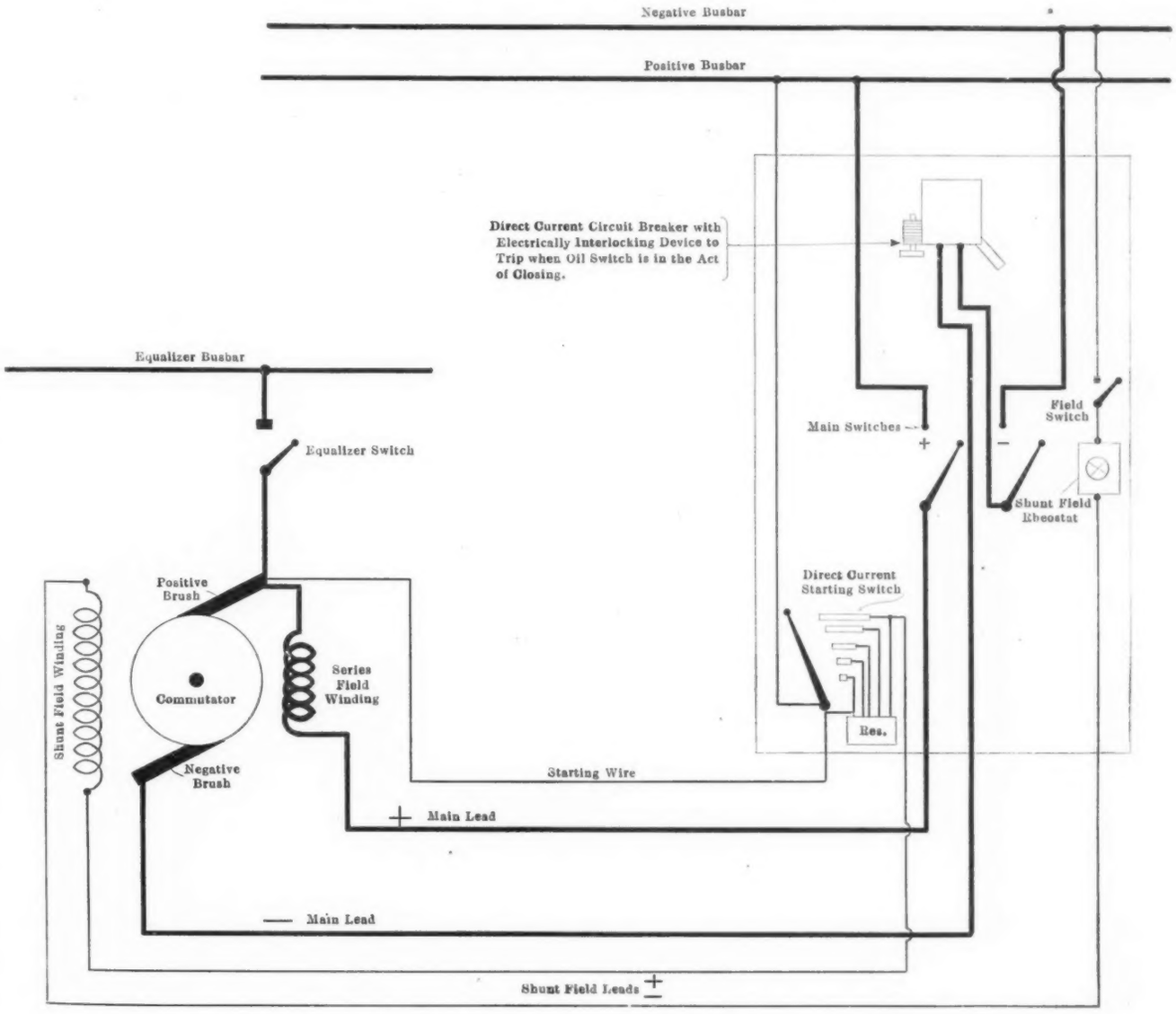


FIG. 1. DIAGRAM SHOWING CONNECTIONS FOR STARTING A THREE-PHASE CONVERTER ON THE DIRECT-CURRENT SIDE

rect-current circuit-breaker as the oil-switch contacts close.

10. Open the starter and negative direct-current switches.

11. Close the direct-current circuit-breaker.

12. Close the equalizer switch.

13. Adjust the direct-current voltage.

14. Close the negative switch.

15. Regulate the load and power factor by means of the shunt-field rheostat and the alternating-current induction-voltage regulator (not shown).

To cut out a rotary converter connected as in Fig. 1, the sequence of operations is as follows:

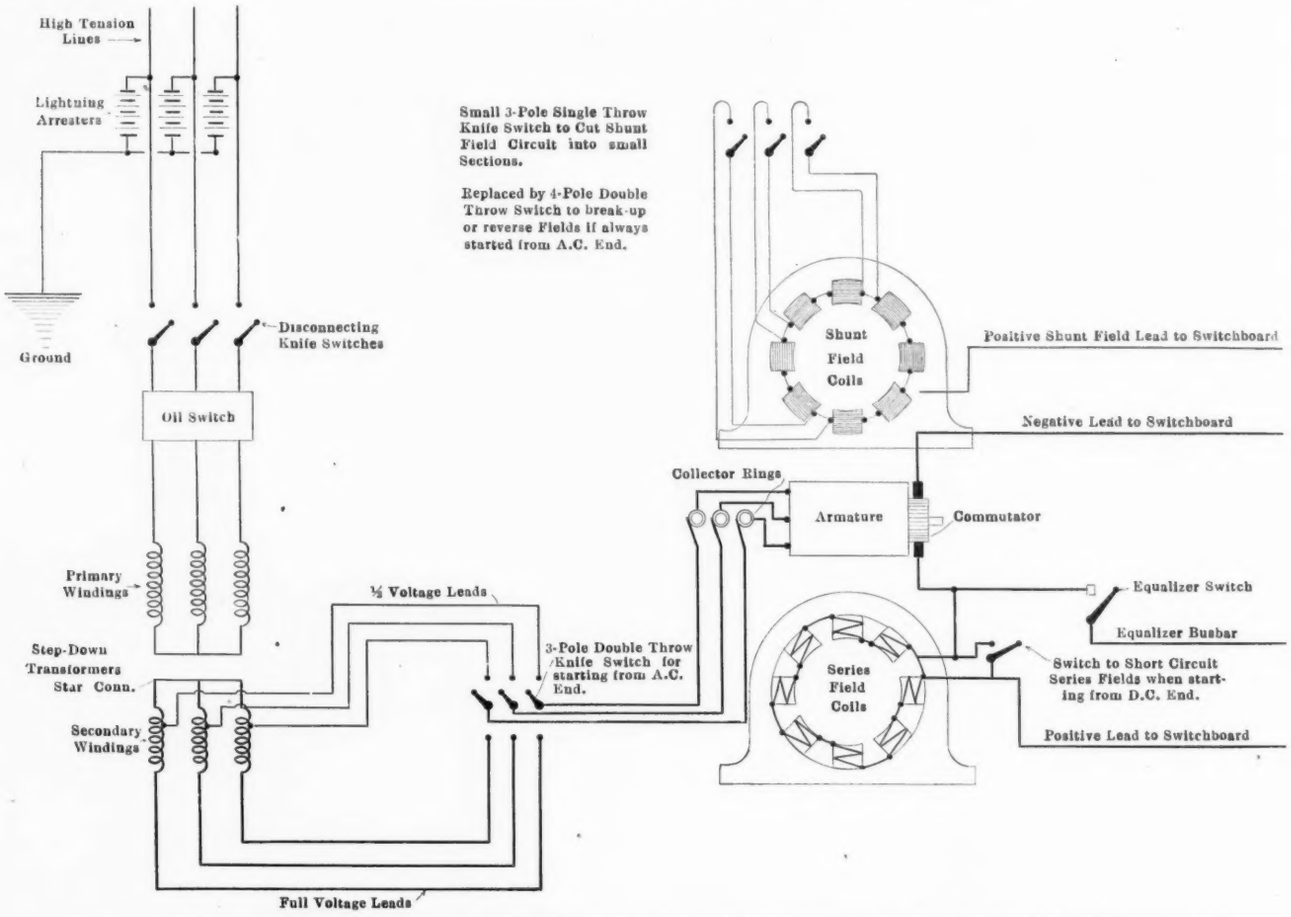

High Tension Lines
Lightning Arresters
Ground
Disconnecting Knife Switches
Oil Switch
Primary Windings
Step-Down Transformers Star Conn.
Secondary Windings
½ Voltage Leads
Full Voltage Leads
3-Pole Double Throw Knife Switch for starting from A.C. End.
Small 3-Pole Single Throw Knife Switch to Cut Shunt Field Circuit into small Sections.
Replaced by 4-Pole Double Throw Switch to break up or reverse Fields if always started from A.C. End.
Shunt Field Coils
Positive Shunt Field Lead to Switchboard
Negative Lead to Switchboard
Collector Rings
Armature
Commutator
Equalizer Switch
Equalizer Busbar
Switch to Short Circuit Series Fields when starting from D.C. End.
Series Field Coils
Positive Lead to Switchboard

FIG. 2. DIAGRAM SHOWING CONNECTIONS FOR STARTING A THREE-PHASE CONVERTER ON THE ALTERNATING-CURRENT SIDE

1. Reduce the load by means of the shunt-field rheostat.

2. Trip out the direct-current circuit-breaker.

3. Open the direct-current negative switch.

4. Open the alternating-current oil switch.

5. Cut in all resistance in the shunt-field rheostat.

6. Open the field switch.

7. Open the direct-current positive switch and the equalizer switch.

Certain minor operations, such as No. 3 and No. 4 in starting and No. 5 and No. 6 in cutting out, might be reversed, but unless there is some special reason for doing otherwise, the stipulated schedule should be followed to the letter. Blunders will inevitably creep in if the slightest laxity is permitted, and almost any blunder that is made may result in irregularities or interruptions in the service of any other machine that may be connected with it on either the direct- or alternating-current side. One of the most common deficiencies of the average operator of converters is a tendency to become careless or hasty after cutting out the direct-current end when shutting down a converter, as it is then doing no useful work; it must be remembered that the machine is still running as an alternating-current motor, and can cause a lot of trouble on the alternating-current line. Three times in one month the operators in a certain station opened the field switch before opening the alternating-current oil switch, and the resulting sudden change in power factor knocked out every converter on the line.

In the arrangement just discussed, the positive switch *must* be left closed as long as the converter is connected to either the alternating or the direct-current circuit, because opening it would break the shunt-field circuit.

Rotary converters may also be started up from the alternating-current end, and this method has its peculiar problems, though the process is somewhat simpler. It requires a rather heavy alternating current to start the converter from a standstill, and this heavy instantaneous demand upon the alternating-current line causes violent fluctuations in voltage and power factor. Then, too, the polarity of the direct-current end depends upon the caprice of the closing of the field circuit. A type of starting apparatus sometimes installed is a three-pole double-throw switch, the blades of which are connected to the alternating-current brushes of the converter; throwing one way connects to low-voltage taps in the secondary windings of the step-down transformers, and the other way to the terminals of the secondary windings, as shown in Fig. 2. In starting, the shunt-field switch is opened, and on some types of converter another switch, which has three or four poles and is connected in the shunt-field circuit in such a manner that it cuts the field winding into several sections, and should be opened also; this switch is sometimes double-throw, and may be used to reverse the field winding to correct the polarity. Then the three-pole double-throw switch is closed to the low-voltage side and the oil switch is closed. The transformer voltage is so proportioned that it will enable the converter to reach synchronism on the low-voltage taps, and when approximately full speed is attained the shunt-field circuit may be closed and the proper polarity obtained, if necessary, by

the manipulation of the field-reversing switch, if one is provided; when synchronism is attained the three-pole switch is thrown over to the full-voltage side very quickly, so the converter cannot drop out of step during the change over. The remaining part of the operation is similar to that given in the first schedule for starting after the oil switch is closed. This is not a very satisfactory method of starting, owing to the violent reactions on the alternating-current line affecting the whole system and the increased cost of wiring and extra switch required; it is usually employed only as an emergency expedient to be used in case of failure of the supply of direct current for starting. Small induction motors are often used for starting converters under similar conditions and they give better results.

When no special apparatus is installed for starting from the alternating-current end and no direct current is available, a converter may be started from the alternating-current end in the following manner: The generators at the station supplying alternating current are slowed down to about half speed and their voltage reduced accordingly; the oil switch on the converter is then closed, leaving the field switch open to prevent the induced currents in the field winding from damaging it. When the converter is up to half speed or more the field switches may be closed, observing the direct-current polarity, which is dependent upon the relative positions of armature coils to the field-magnet poles at the instant the field switch is closed. If incorrect, repeated opening and closing of the field circuit and the oil switch will produce the desired polarity sooner or later. When the correct polarity has been obtained, the generators are brought to full speed, and the ensuing procedure is the same as that of starting from the direct-current side beyond the point where the converter is synchronized.

In one of the first large converter stations installed west of the Alleghanies a cause of trouble which was not readily located was due to starting the converters from the alternating-current end and using a "hollow coil" direct-current voltmeter which had no fixed polarity. When the polarity was wrong the voltmeter would not indicate the fact, and when the operator attempted to cut in one 900-kilowatt converter with reversed polarity on a 600-volt line with two or three others, everything involved in the entire system went "up in the air." Everyone connected with the installation was ignorant of the fact that the polarity was such a matter of chance and could become reversed so easily, and the cause for the trouble remained a mystery until a different type of voltmeter was substituted in a desperate effort to locate the cause.

Three-phase rotary converters are frequently used to supply three-wire direct-current distribution systems by connecting the step-down transformers in star and grounding the central point of the star, which is the neutral point between the positive and negative direct-current terminals. This adds another circuit-breaker and switch to the list to be manipulated, these being closed after all the other operations are performed when cutting in, and opened first of all in cutting out.

Still another addition is that of a comparatively large switch to connect the positive main lead direct to the positive brush-holder, cutting out the series fields, as shown in Fig. 2. This allows the main lead to be used for starting and is quite frequently done to avoid running a separate starting wire from the switchboard to each converter. The switch must be closed before starting from the direct-current end, else the starting current will flow in the wrong direction through the series-field winding and cause trouble by opposing the effect of the shunt-field winding, producing insufficient magnetism in the field-magnet cores. After the converter has been synchronized and is running on alternating current, the switch may be opened, so the series-field winding will come into action when the machine is cut in, or it may be left closed and the converter operated as a plain shunt-wound machine. Rotary converters usually have an "oscillating device" to cause end play of the shaft, to allow the brushes and journals to wear easily, and an automatic speed-limiting device to trip the direct-current circuit-breaker in case of dangerous rise in speed which may arise from failure of field current and other causes. These should be kept in perfect order, and the direct-current circuit-breaker must be set to operate on a comparatively small overload, as rotaries will not stand as much hard usage as direct-current generators of equal capacity.

Cleanliness is indispensable to successful operation of rotary converters, just as in the case of generators, and it is more difficult to maintain because the winding is necessarily more concentrated, and this increases the tendency to collect dirt as well as making it more difficult to clear it away. It is also conducive to continuity of operation to let the brushes and brush holders severely alone when the converter is running. The point of commutation is very definite, and the sudden displacement of the brushes by the width of one or two commutator bars, or sometimes even less, may cause them to spark so violently that the machine will flash over from one brush-holder to another, tripping out all the safety devices of the disturbed converter and probably any others on the same circuits. Any sudden change in voltage, load, or power factor, such as may be caused by switching in a large induction motor on the alternating-current lines or by a comparatively mild short-circuit on the direct-current line is likely to produce similar results, especially if there is not much reaction in the alternating-current circuits leading to the converters.

Fourteenth Annual Convention of the Ohio Electric Light Association

At the sessions of this convention, held at Put-in-Bay, August 25 to 27, it was evident that gas engines and high-efficiency lamps were the two subjects of greatest interest to the members. This was but natural, as the progress in these two lines has made it necessary for managers of lighting plants to study the subjects very carefully in order to obtain the most benefit from the developments therein. Many other important questions were also taken up, so that each member gained some information that will be of help to him in his daily work.

Two hundred and twenty delegates were present, 54 plants being represented; during the sessions 11 new active and 18 new associate members were admitted.

The new officers elected were: C. R. McKay, of Toledo, president; J. C. Rothery, of East Liverpool, vice-president; D. L. Gaskill, of Greenville, secretary and treasurer, the latter being reëlected.

Special attention was paid to the entertainment feature; card parties for the ladies, lake bathing for all, a grand ball and an impromptu vaudeville performance were some of the enjoyable features of that part of the program. In addition, the historic caves and other points of interest on the beautiful island were visited, as occasion permitted.

A banquet, with vaudeville between courses, tendered by the association to all members and guests, was the concluding feature of the convention, which will be remembered as one of the most satisfactory meetings of the organization.

It has been estimated that a square foot of uncovered pipe, filled with steam at 100 pounds pressure, will radiate and dissipate in a year the heat obtained by the economic combustion of 398 pounds of coal. Ten square feet of bare pipe corresponds approximately to two tons of coal per annum.

Handling coal on the Great Lakes is now accomplished with amazing rapidity; 54,273 tons of coal, 9000 anthracite, the remainder bituminous, were recently unloaded in one day at Superior, Wis. In 17 hours, 7152 tons were unloaded; this is at the rate of 140 tons per hour.

Keep the gage cocks clean and try them frequently. See to it that all the connections to the water glass and water column are free. Do not depend upon the water glass. It is convenient but not always reliable.

The Plunger Hydraulic Elevator

The Construction of the Plunger Itself; How the Pilot and Starting Valves Are Operated; Functions of the Main Operating Valves

BY WILLIAM BAXTER, JR.

Plunger Construction

The construction of the lower end of the plunger is shown in Fig. 248. The main portion consists of a casting D' to the upper end of which is screwed the lower end of the plunger. This casting does not run up to the oil well in the stuffing box with normal operation of the elevator; therefore, its surface, if of iron, would soon become rusty. On this account it is covered with a brass casing D''. At the lower end of D' spaces are cored out to receive the guide shoes A, pivoted at the upper ends at A', and held from moving too far outward by a ring C at the extreme lower end of the casting D'. Provision is made for either three or four shoes like A. The springs B press the shoes out against the cylinder and hold the lower end of the plunger central.

The main operating valve used with the Otis plunger elevator for high grade passenger service is made in several designs. The valve shown in Fig. 245 is constructed as shown in Fig. 249, the pilot valve part being more clearly illustrated in Figs. 250 and 251, drawn to larger scale. The pipe I shown in Fig. 245 connects the inlet P of the pilot-valve chamber and the inlet B^2 of main valve with the supply pipe, through the limit valve A. In like manner the pipe J connects the outlet P' of the pilot-valve chamber with the discharge, through the limit valve B. The inlet O on the pilot-valve chamber is connected with the inlet A' at the back end of the main valve cylinder by means of the pipe marked K in Fig. 245.

The operation of the valve is as follows: When the elevator is not in motion the valves are in the position in which they are shown in Figs. 249, 250 and 251. The space between main valve pistons A and B is filled with pressure water, as it is permanently connected with the supply pipe, as shown in Fig. 245, by the pipe I. The space between the valve pistons D and E is permanently connected with the supply through the pipe M, shown in Fig. 245. The space between the valve pistons B and C is connected with the discharge through the pipe N. The space back of piston A is filled with water through the pipe connection running from A to the inlet O on the pilot valve chamber, and as the pilot valves are closed this water cannot escape, hence the valve A cannot move to the left. If it is desired to run the car upward, the operating lever G is raised and the through the connecting levers H and J the connecting rod K is drawn to the right, and the valve T', Fig. 250, is thereby opened, and the water back of the valve piston A escapes into the pilot valve chamber through the inlet O and out through the valve T' and the valve R' to the outlet port P', following the path through the outlet X. As the pressure on the right-hand side of the piston A is greater than that on the left-hand side

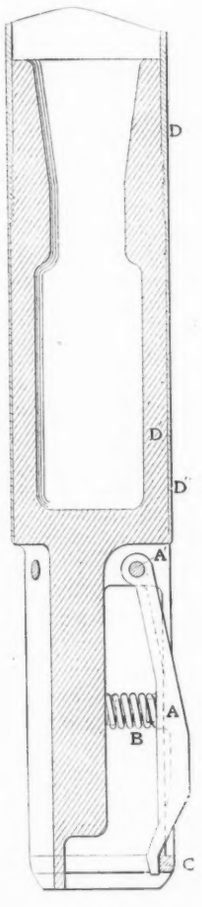


FIG. 248

of B, the main valves will be moved to the left, and pressure water will pass by the valve piston D and into the pipe connecting with the lifting plunger cylinder, and the car will be mover upward.

The movement of the main valves to the left will cause the pilot valve to move in the same direction, as the valve rod F, through the connecting rod F', will carry the lever F'' to the left, swinging the fulcrum H' downward, and, through the link H, moving the rod K. The movement of the main valves to the left will continue until, through the motion of the lever F'', the pilot valve has been carried far enough to the left to close the valve T; then the outflow of water from behind the piston A will cease, and the main valve will move no farther. In this respect the operation is the same as that of every type of pilot valve that has been explained in preceding articles. The distance through which the main valves will move is evidently proportional to the distance through which the pilot valve is moved by the lever G, for the movement of the main valve must be sufficient to return the pilot valve to the closed position, and no more.

The Pilot Valve

Although the operation of this pilot valve is the same in general as that of all other pilot valves insofar as it has been explained, it possesses one feature not found generally on the pilot valves of the hoist types of hydraulic elevator. It will be noticed that there are apparently two pilot valves, V and V'. In reality only V is a pilot valve, the valve V' being supplied for the purpose of controlling the distance in which the elevator can be stopped. Referring to Fig. 249 it can be seen that when the lever F'' is moved to the left, as the main valve opens to let pressure water flow into the lifting cylinder, the upper end of F'' carries the lever K' to the right, and this moves the valve V' to the right while the valve V is moved to the left. This is the action when the pilot is moved to start the car, but when it is desired to stop the car on the upward trip, the lever G is moved downward, and then the pilot valve V is moved to the left and the valve T is opened, allowing pressure water from the inlet P to pass through the valves R and T into the pilot valve chamber and through the outlet O to the inlet A' at the back end of the main valve, thereby equalizing the pressures on both sides of the piston A; the unbalanced pressure on the left-hand side of B will then force the main valves to the right and shut off the flow of pressure water from the supply pipe into the lifting cylinder.

Looking now at Fig. 250 it will be seen that when the pilot valve V is in the central position, the valve V' will also be central, and the end valves L and L' will be opened, so that water can flow freely from the inlet P to the port U without passing through the port U', and also

flow out from the passage X to P' without going through X'. The valve S in the port U' checks the flow of water so that a much smaller quantity can pass through U' than through U; hence if the valve L is closed, so that water has to flow in through U', it will require much more time to fill the space back of the main valve piston A, Fig. 249, that if the water were flowing through U. Now when the lever G is raised to send the car upward, the movement of the main pistons to the left will carry the valve V' to the right, and thus carry the valve L into the opening through which water flows into the port U; therefore, when the pilot-valve lever G is depressed to stop the car, the main valve will not move back rapidly to the stop position, in which it is drawn, because the water flowing in from P to move the main valve has to pass through the restricted passage U; therefore the return movement of the main valve is much slower than the forward or starting movement.

It is evident that by adjusting the opening through the valve S the flow of water through U' can be made as slow as desired. As will be seen from Fig. 251 the valves R R' and S S' are simply plug valves that can be adjusted for any amount of opening and held permanently in that position. The object of using these valves and the valve V' is to provide positive means to control the rapidity with which the elevator can be stopped. In a plunger elevator, if the car is stopped very quickly on the up trip, the momentum of the upward moving car and the downward moving counterbalance will tend to continue the car travel and as a result the plunger will move away from the water in the cylinder. As soon as the car stops, it will run back and stop suddenly when the plunger strikes the water. If the car is coming down and the operator stops it suddenly, the momentum of the car and its load will tend to buckle the plunger. As it is not possible for an operator to judge just how fast to move the operating lever to make as quick a stop as can be made without causing the plunger to leave the water on the up trip, or to buckle on the down trip, it is necessary to provide means for controlling the rapidity of stopping, and the valves described are the means provided for this purpose. With this arrangement of valves, the operator can make as slow a stop as he may desire, but if he moves the lever G instantly to the stop position, the elevator will be brought to a state of rest gradually in the shortest practical time, but no sooner. The time or distance in which the car will be stopped can be varied as desired by changing the adjustment of the valves S S'. The valves R R' are provided to prevent too rapid a start.

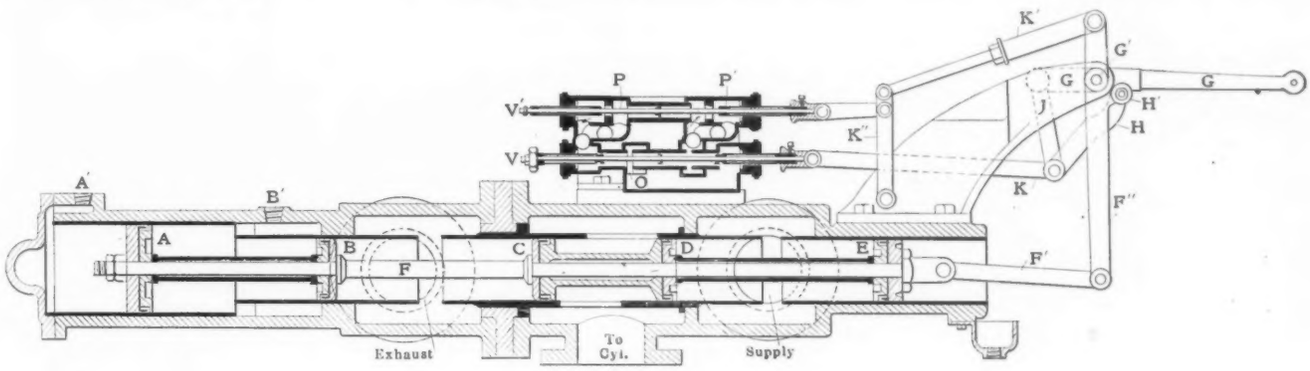
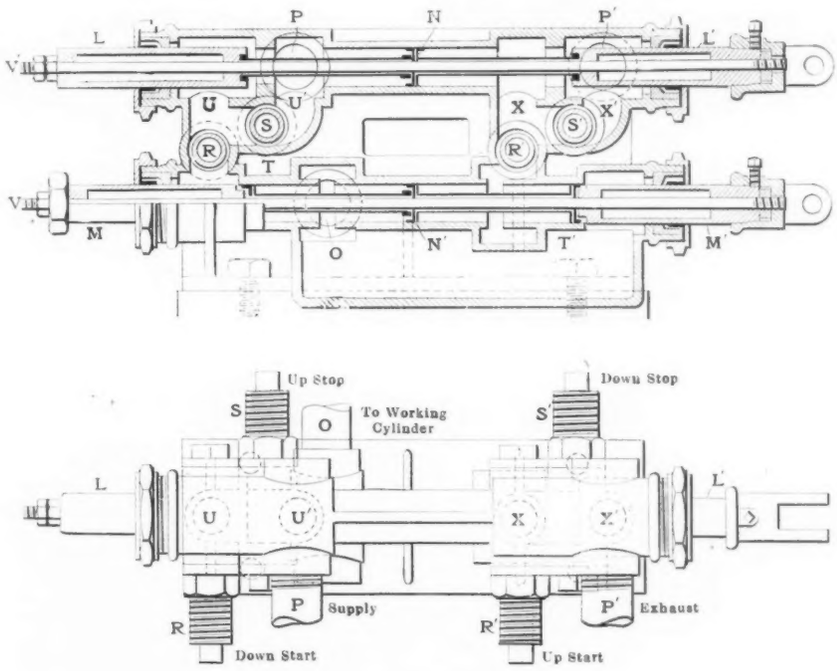


FIG. 249



FIGS. 250 AND 251

Gustav Zeuner and His Work

To every man who can intelligently run a steam engine the name Zeuner is like a household word, because of its inseparable connection with the most familiar form of slide-valve diagram. Those who are well read on engineering subjects are acquainted with Gustav Zeuner through his treatise on valve gearing, which has been used as a textbook in leading American schools. They may have read also his "Technical Thermodynamics." But so little is the personality of the author known on this side of the ocean that his dropping off the list of living engineers, which took place late last autumn, was an event which may have passed unnoticed by most of our readers.

Professor Zeuner's illustrious services to his profession, lasting half a century, received more direct personal recognition in his own country, Germany, where he was reckoned with such patriarchs of steam engineering science as Weisbach, Hirn and Rankine. It was fitting that at a recent meeting of the Verein deutscher Ingenieure, in Dresden, the city where Zeuner labored for many years as an educator, Prof. Dr. R. Mollier, of that place, should pay tribute to the deceased with an account of his professional work. From that paper are derived the facts and criticisms here presented.

Gustav Zeuner was a selfmade man. Eighty years ago he was born in Chemnitz, of carpenter parentage. He first learned his father's trade, but the desire for higher knowledge took him into technical schools, bringing him at the age of twenty into the famous old mining academy of Freiberg. Here he came under the influence of Julius Weisbach, professor of Mechanics and Machine Design, a celebrated hydraulic authority with whose work Zeuner's name later became associated in several ways. After studying a while at Freiberg, Zeuner taught temporarily at various places and also took a course in the university of Leipzig, whence he graduated with a work relating to crystallography. In 1853 Weisbach, Bornemann and Zeuner started a periodical, *Der Civilingenieur,* to which in after life many of his writings were contributed.

In 1855, at twenty-seven years of age, he was made professor of Mechanics and Machine Design in the newly founded Polytechnic at Zürich, where in an atmosphere favorable to his development much of his best scientific work was done. In 1871 he accepted a call to Freiberg as successor of Weisbach, then deceased, and as director of the school with a view to reorganizing it and bringing it up to date. A year and a half later he was made professor in the same line and standing director at the Dresden Polytechnic, but coincidently kept up his work of reorganization at Freiberg until 1875. It was largely through his efforts that the Dresden institution was transformed into a technical high school, with an elected director, in order to permit which he laid down his standing directorship in 1890, al though continuing his teaching labors until invalided in 1897. This, however, did not end his literary activity. His long administrative service at Freiberg and Dresden had been efficient and resultful. Such is an outline of his career as a direct educator.

His life influence as an indirect educator by means of his writings is a larger subject. This field of instruction he cultivated early and late, having relatively little time for it when acting in his executive capacity. At the start, from 1854 to 1858, he wrote on hydraulics, water turbines, etc., to which he reverted in a work, "Theory of Turbines," brought out in 1899. In 1856 he began to concern himself with valve gears and he published his book on that subject in 1858; this book presented the first adequate practical graphic treatment of the valve movement. The relation of this fundamental method to subsequent study of the steam engine may be judged by any man who today draws a valve diagram.

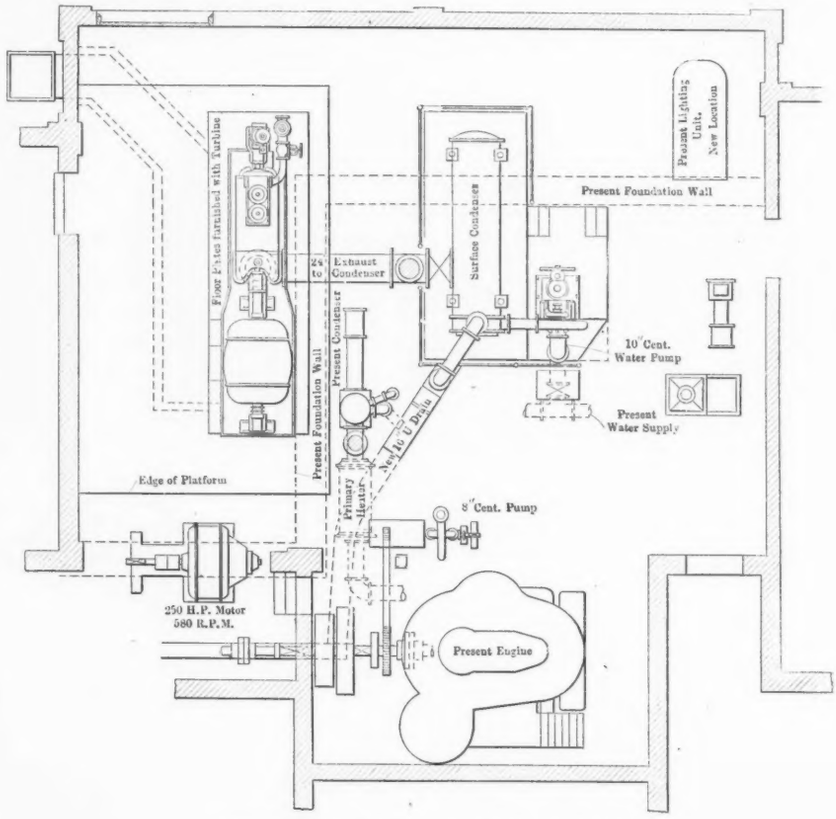
A still more important task was performed by Zeuner in his treatment of the mechanical theory of heat. In this he is claimed as sharing supremacy with Rankine only. Rarely does a scientific work so markedly bear the stamp of a single personality as does his "Basic Principles of the Mechanical Heat Theory" (1860), or "Technical Thermodynamics," as the book was called in late revised editions. (An edition in English translated by Prof. Klein, of Lehigh, has recently been published in New York, thus showing the enduring reputation of the work.) Zeuner was especially successful in presenting his matter clearly with few mathematics, and with diagrammatic treatment. He led his readers firmly and confidently along on the experimental data available, especially those of Regnault, whom, when a young man, he had sought out in Paris and whom he held in high esteem. From Regnault's results he calculated his saturated steam tables. His first discussion of superheated steam appeared as long ago as 1867.

Studies of the flow of gases occupied much of Zeuner's attention. They are evidenced in his book, "Locomotive Steam Blower" (1863) in discussions of injectors and orifices, etc. His "Theory of Turbines" extended to the principles of the steam turbine and here, for the first time it is said, he clearly traced the proper proportions for flow of steam through diverging nozzles, as in the De Laval turbine Such investigations were promoted by experiments of his own. In 1897 he made some tests of the flow of air through rounded orifices, which he mentioned in a late edition of his "Technical Thermodynamics."

Zeuner's versatility was exemplified by his interest in matters of insurance and statistics, lectures on which he delivered at the Zürich school, and it was while he was there that his "Discussions of Mathematical Statistics" was brought out.

A Steam Turbine Driven Paper Mill Plant

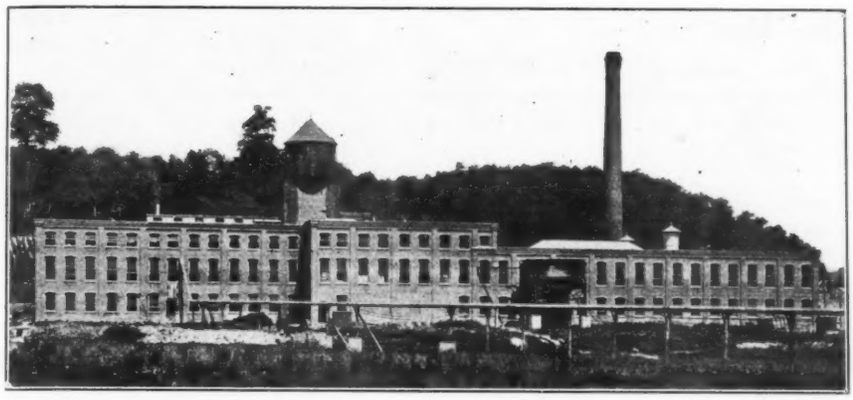
An especially interesting and complete installation of the Westinghouse-Parsons steam turbine with a direct-connected alternating-current generator has recently been completed at the Megargee Paper Mills, Modena, Penn. It is of additional interest as being one of the very first applications of the steam turbine to the paper industry.



PLAN OF ENGINE ROOM, MEGARGEE PAPER MILLS

At this mill, the entire power was formerly furnished by a 500-horsepower Reeves vertical engine, but when it became necessary to double the capacity of the mill, and consequently to increase the engine-room output, it was found that in order to install another or a similar engine the building itself would have to be considerably altered in order to provide the necessary extra room. To meet this difficulty it was decided to substitute motors and electric drive for the old line-shaft transmission, and to install the steam turbine-driven generator, since in this manner the necessary increase of power could be obtained without enlarging the building. The entire mill, with

the exception of two large paper-making machines, is now operated with power from the turbo-generator. The exception



THE MEGARGEE PAPER MILLS

in the case of the paper-making machines referred to was made because it has been found desirable to use separate steam engines for each of these machines, and to use their exhaust steam for heating the rolls over which the paper is dried.

The turbine is of 775 kilovolt-amperes capacity, and guaranteed as follows:

POWER DELIVERED AT THE SWITCHBOARD.

Full load, 26-in. vacuum..... 23.3 lb. per Kw.-hour
Half load, 26-in. vacuum..... 30.8 lb. per Kw.-hour
50% overload, 26-in. vacuum, 25.2 lb. per Kw.-hour

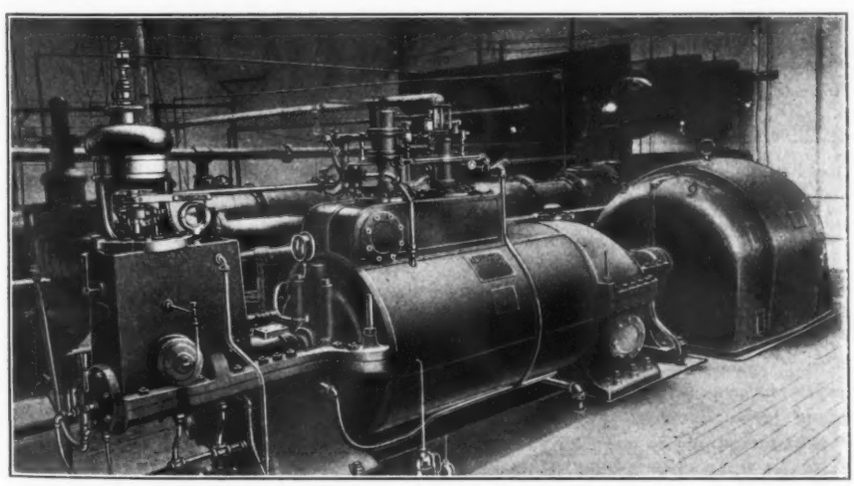
Under test at the factory it gave:

Full load, 26.81-in. vacuum.... 20.3 lb. per Kw.-hr.
Half load, 26-in- vacuum..... 25.15 lb. per Kw.-hr.
50% overload, 25.52-in. vacuum, 22.65 lb. per Kw.-hr.

The dimensions are:

Length of turbine	12 ft. 2 in
Combined length of turbine and generator	21 ft. 3 in.
Width	4 ft. 6 in.
Hight	6 ft. 9 in.
Weight of turbine	27,700 lb.
Weight of generator	19,250 lb.
Revolutions per minute	3,600
Steam pressure at gage	125 lb.

Overload capacity, 50 per cent.
Speed variation under normal conditions not to exceed 2 per cent.



TURBO-GENERATOR SET, MEGARGEE PAPER MILLS

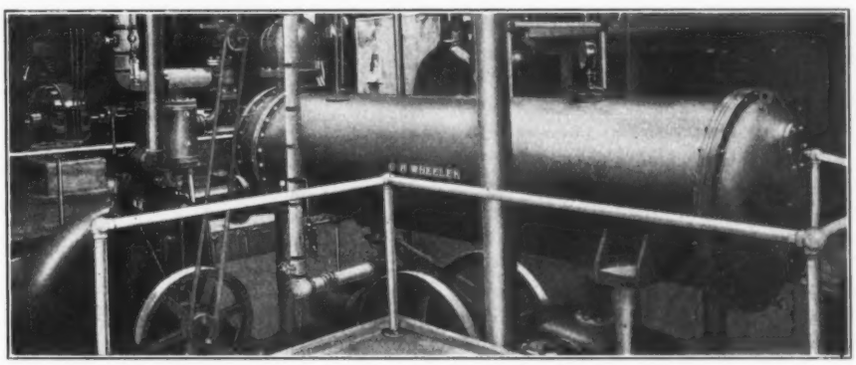
No efficiency test has been made at the mill, but the same boilers, which had been working at full capacity before the mill was enlarged, still supply sufficient steam for the 50 per cent. increase in power, with no noticeable increase in fuel consumption.

The generator is direct-connected, 60-cycle three-phase, and is capable of delivering 1020 amperes at 440 volts. The exciter dynamo is rated at 90 amperes at 100 volts. Under 100 per cent. change of load, the change in the alternator voltage is guaranteed not to exceed 12 volts.

The generator efficiencies are guaranteed as follows: With half load, not less than 91½ per cent.; with three-fourths load, 94 per cent.; with full load, 95 per cent.

The exhaust from the auxiliary engines goes to an open-type feed-water heater, and the hot-water returns from the steam-heated rolls of the paper-making machine go direct to the hot well. The exhaust from the turbine goes to a C. H. Wheeler surface condenser, which contains 2300 square feet of cooling surface. Circulating water is supplied by a centrifugal pump, direct-connected to an 8x9-inch marine-type engine; the air pump is an 8x16x12-inch of the Mullan horizontal-crank and flywheel suction valveless type. The entire condensing outfit was manufactured by the C. H. Wheeler Manufacturing Company, of Philadelphia. During a recent visit, with an initial circulating water temperature of 74 degrees Fahrenheit, the condenser was maintaining a vacuum of 28½ inches.

The accompanying plan of the engine room was obtained through the courtesy of George F. Hardy, of New York City, who designed the plant and had entire charge of its construction.



C. H. WHEELER SURFACE CONDENSER, MEGARGEE PAPER MILLS

Boiler Room Helps

Do not close the damper entirely with fire in the furnace, as gas is liable to accumulate in the combustion chamber or tubes and cause an explosion.

Bags should be repaired immediately. If not down too far and the metal is sound, they can sometimes be driven back, otherwise it will be necessary to cut out and patch.

Keep the boiler clean and dry on the outside. Do not allow wet ashes to accumulate around water legs or other parts of the boiler. Do not allow water from leaking joints or other sources to come in contact with the boiler.

In case of foaming, close the throttle and open the fire doors for a few minutes, when the water will usually settle and the proper hight may be ascertained. The trouble, if caused by dirty water, can easily be overcome by feeding and blowing. Where there is a surface blow it can be used to good advantage.

The Purchase and Use of Packing*

Why the Best Is the Most Economical; How Packing Sometimes Mysteriously Disappears; Cutting and Lubricating; Pitting, Etc.

BY W. E. SANDERS

In buying packing the engineer or purchasing agent should always bear one point in mind. The expense for packing is an operating expense rather than an initial cost. This is entirely true of all rod packings and of gaskets where joints must be broken, so that the cost per year should be determined and the buying done on that basis, just as the fuel cost depends not so much upon the price per ton, as it does upon the cost for a given length of time. In other words, the quality must be taken into consideration. Poor fuel will result in extra labor and extra expense for cleaning and repairs and will cut down the amount of steam that can be made. Poor packing requires extra labor. Sooner or later it requires extra expense in the replacing of rods which have been worn away by excessive friction, and more than this, the effective steam power is lessened by the work done in overcoming friction. The old principle of "the best is the cheapest" applies in packing supplies as well as in anything else.

This is not so apparent in the purchase of gaskets, for after a gasket is put in it will stay indefinitely, although one blow-out may cost far more than a hundred gaskets. At the same time most failures of gaskets are due to wrong insertion or to their not being cared for properly after being put in, rather than to the material used.

In buying both gaskets and rod packing it should always be remembered that a shut-down of a very few minutes to replace a gasket or to repack an engine costs hundreds of times more than a few cents extra per pound for first-class goods. Packing expenses should always be considered as operating expenses.

Mysterious Disappearance of Packing

One cause for complaint against packing is really not due to the packing itself. Engineers have frequently complained that packing was used up very rapidly. They could not tell where it had gone. It certainly did not come out of the stuffing box, and their assumption was that it had worn away. Very frequently this loss is caused by the large clearance around the rod at the bottom of the box. There is always some clearance allowed by engine builders, and in the cheaper class of engines this clearance is very large. In the higher class and more expensive engines this clearance is reduced to a minimum. Wherever there is much clearance, the packing will sooner or later be pushed or drawn through into the cylinder, and, of course, is finally worked out of the exhaust ports.

In other systems curious results are sometimes found. The writer knows of an instance where a piece of packing worked through the stuffing box of a feed-water pump and blocked the regulator, controlling the supply of water to the boiler. Such instances as these are by no means uncommon. To get around this it is best to make a brass or babbitt-metal ring which will fit in the bottom of the box. It is often advisable to keep a little pattern of this ring and during odd moments cast a number of babbitt-metal rings in a small box of sand. These rings must then be bored out so that the inside of the ring just fits over the rod. Then cut the ring in two with a hack saw and obtain two sections which can be placed in the bottom of the box. The amount cut out by the blade of the hack saw will allow these two rings to fit snugly to the rod, and more than this, they will square the bottom of the box. By using these rings two points in particular will be gained. A square-bottom box which gives the packing a better chance to work properly will be secured, and the clearance will be blocked up so that the packing cannot be forced or drawn through into the cylinder. A third point, not at first apparent, is the fact that these close-fitting rings will prevent a large amount of steam from passing from the cylinder to the box. The packing, therefore, has less work to do and will last longer and be more satisfactory. In some machines the manufacturers themselves will put in a babbitt bushing which can be renewed easily from time to time.

Cutting Packing Rings

Before attempting to pack a box, the engineer should examine carefully the packing that he intends to use and see upon what principle it is made and how it should be applied. If the packing is of the common monkey-wrench type, it will make no difference, but if it is of the automatic sensitive-wedge type, it is necessary that the cushion should go next to the cylinder, and that the wedge nearest the cushion should be next to the rod. If placed in any other position, it is certain that it will not work satisfactorily, and it is almost certain that it is doomed to failure.

In cutting rings of packing, the packing should be bent around the rod, care being taken that it is in just the position that it will be when placed in the box. The rings should then be cut either square-ended or scarfed. It will probably work all right if cut square-ended, but it is better on the whole to cut the packing with a beveled or scarfed end. Packing rings should never be cut exactly the right length. There should be a space between the ends of the rings of anywhere from ⅛ to ½ or ⅝ inch, according to the size of the rod. This space gives an allowance for expansion of the packing endwise. This is a very essential point, for if the packing is made to fit around the rod exactly and no allowance is made for end expansion, when the packing becomes warmed the rubber will swell, and as the packing cannot expand freely endwise, it will buckle; and a ring that has once buckled might as well be drawn out and thrown away. It is of no further use.

Lubricate the Packing

When the rings are cut they should be dipped in cylinder-oil before placing in the box. Oil has a bad effect upon rubber, and it would seem as though this direction were wrong. It is true that the rubber in the packing suffers when it comes in contact with oil, but the oil reduces the friction to such an extent that the gain is far more than the loss. Few engineers appreciate what lack of lubrication on packing means. If the packing is not lubricated, there will be friction on the rod, and if this friction becomes too great, the packing swells and increases the pressure, which in turn increases the friction on the rod. The temperature of the rubber rises and it becomes so hot that it loses its life, and at last becomes charred or burned. A little lubrication at the start will often prevent this.

A packing should be lubricated in exactly the same manner as a bearing. This can be done by so placing an oil cup that the oil will drop directly on the rod, or by keeping a swab of waste in touch with the rod and allowing the oil or grease to flow upon it. A single example will show the importance of this lubrication. A test was run on twin engines. The same kind of packing was used, but on one engine the packing was lubricated and on the other engine it was not. At the end of four

*Copyright, 1908, by W. E. Sanders.

weeks the packing on the engine which was lubricated was in first-class condition, while on the other engine the packing had been replaced four times.

After the rings have been dipped in cylinder-oil, they should be placed in the box, and, if the packing is a diagonal or automatic packing, care should be taken that it is placed in the proper position, and successive rings should break joints, that is, the opening in one ring should not come over the opening in another ring. The packing should slip in easily, and if it does not, do not try to jam it in. There are some packings that will stand this jamming, but with automatic and sensitive packings the effect of jamming will be simply to bind the packing more. Instead of trying to force it, take the ring out and with a flat piece of board press it slightly onto the rod. This will tend to thin the packing a little bit, and it will probably then enter the box easily. The box should be filled up to within about ½ or ¾ inch of being full. This distance varies with the size of the rod, and it is left so as to allow the gland a little chance to get a start. The gland is now brought up against the packing, and, using the gland as a battering ram, the packing can be forced into the box so that it fits snugly. It is not necessary to jam this packing in, but at the same time it wants to be snug.

When this has been finished, bring up the nuts on the studbolts with the thumb and forefinger only. A wrench should never be used. It is a good plan sometimes to run a locknut on the studbolt ahead of the gland, and when the gland has been set in proper position, bring this locknut back to hold the gland firmly.

Methods of Packing Determine the Engineer

The difference between a good engineer and a poor engineer is often shown by his actions after he has packed a box. An inexperienced engineer will be impatient, and if there is the slightest leak, either of steam or water, he will immediately grasp a wrench and tighten up on the gland. This is unreasonable. An experienced engineer will let the steam blow for a while, two or three hours or more, and then will begin to adjust the gland very slowly and never with a wrench. A packing should be as loose as it can be, but still do the work. The less tightly the gland is set up, the less friction to be overcome. It is possible to set a packing up so tightly that the rod cannot be moved even by the use of steam. If patience is used the packing will become warm and set itself into position and will then require no attention for a long time.

A certain engineer, known to the writer, is in charge of an ammonia compressor, and in using rubber rings of a special ammonia compound, has a special method of his own. He forces the gland down with a wrench and runs until the packing smokes. Just the instant it begins to smoke, he slackens up his gland and then brings it up with the fingers only. His object is to work the packing thoroughly into every part of the box, and when it is once set, slacken off the gland so that it will not burn. This is rather risky, but that it works is shown by the fact that pure rubber rings in this plant will last over two years, which is a fair record for that sort of service.

Packing as a Bearing

In a stuffing box the packing forms a bearing just as truly as the babbitt metal in a shaft bearing. The piston and piston rod are supported by the wrist pin and by the packing rings in the cylinder. The support at the wrist-pin end is fixed in a measure, but, of course, the slippers on the crosshead will wear at times so that the piston-rod is liable to drop. More than this, the packing rings on the piston are subject to wear, and the piston may drop at that end. This means that the whole rod will drop, and it often becomes necessary to manufacture a packing in which the hole for the rod is not in the center with the outside circumference of the packing. It can readily be seen that while the rod is not running on the center line, it must be supported more or less by the packing.

In this connection an extreme case, where a packing forms a bearing, might be mentioned. This is in the shot-gun feed of a sawmill. The stuffing box in this instance is about 18 inches long. The rod which pulls the carriage on which a log is placed and sawed up into slabs is very long, and as the carriage runs over chips and dirt, it is constantly subject to vibration. More than this, the rod, because of its length, is supported in a great measure by the packing, and as a result is a difficult proposition to pack. One method that has been devised, is to place in front of the box a quarter bearing which is adjustable in hight. This carries the weight of the rod and relieves the packing of the weight. It has been found that where this device is used the packing lasts very much longer, since it does not have to act as a bearing and is not subject to that wear. This is, of course, an extreme case, but illustrates what is true of all horizontal packings.

For Corliss valve stems it is best to use a ring of asbestos in the bottom of the box, particularly on admission valves. The valves are always in contact with live steam, and consequently have a higher temperature than any other part of the engine. If a ring of asbestos is placed in the bottom of the box, it serves to protect the rest of the packing from the high temperature of the live steam. As the valve has a rotating stem, the packing used should not have spiral threads, but the plies of cloth should lie in a plane perpendicular to the axis of the road.

Temperatures

This suggests the temperature of the stuffing box, which is never the same as that of the live steam. Where steam is used expansively, it cools down and a constant temperature is not available for heating the rod and box. More than this, the rod is exposed to the air half the time, and as the stuffing box has a considerable surface for radiation, the resultant temperature within is considerably less than that of the live steam. If the cushion is so placed that the packing is protected from direct contact with the steam, its temperature will be considerably less than that of the live steam, and it is this fact that makes the use of rubber and cotton possible. If the same packing were thrown into the live steam or exposed directly to its temperature, it would very soon carbonize and crumble up.

Pitting

If the packing is used properly and care taken, a rod can be kept in good condition almost indefinitely. But if abused, it may become scored or pitted. One cause of pitting is leaving the packing in when the engine is down and out of service. The packing retains some of the moisture which has leaked through from the steam main, and this moisture eats into the rod. This is particularly true in the case of dinkey locomotives, such as are used by contractors. These engines are used during part of the year and laid up during the winter. If the packing is not removed when they are laid up, they will invariably have rods that are pitted and in bad condition in the spring. An engineer can improve a pitted rod, or a rod that is scored slightly, by making a mixture of about equal parts of tallow and white lead and swabbing this on the rod three or four times a day with a small wooden paddle. The tallow melts and helps to flow the white lead into the pits or scores and gradually fills them up with lead. It is a good plan to use this mixture on new rods. It will fill in the small pores which are not perceptible to the naked eye, and in a short time the rod will be as glossy and smooth as though it had been running for years.

Scoring is due to the retaining of some grit in the packing. It is very seldom that this grit appears in the packing itself, but if the packing be dropped upon the floor, or has had some such careless usage, it will pick up grains of sand and hold them, just as the setting of a diamond holds the diamond in position. The rod will become scored through the action of the sand or grit imbedded in the packing, but unless it is badly scored, this defect can be corrected as stated above.

A rod with a shoulder is a hopeless case and should be replaced as soon as possible. This shoulder is generally found on brass pump rods, and appears there more quickly because the brass is softer than

steel and more quickly worn down. Almost invariably it is evidence of the use of a poor grade of packing, such as monkey-wrench packing, or of the ignorance of the man handling the packing, coupled with the too free use of a wrench. Under these conditions it never should be expected of any packing to give satisfactory service, for the shoulder tends to unseat the packing at the end of each stroke.

Occasionally a rod will be found sprung, and such a rod should be taken out, for it never will get better, and in fact will usually get worse. For brass rods a careful selection of the lubricant should be made. It is a fact that some lubricants, which are placed on packings when they are sold, will heat or corrode a brass rod even if left over night. This is probably due to acids contained in the lubricant, which is usually a cheap oil.

Catechism of Electricity

748. *Is the synchronizing transformer connected permanently to the one alternator?*

No; in practice the winding on the left in Fig. 261 is connected to plug switches by means of which it may be connected to any one of all generators that are intended to operate on the bus bars *d, e, f.* A switch is also provided for connecting the other primary winding to the bus bars for synchronizing and disconnecting it when not synchronizing. This winding, however, is never connected to anything else but the bus bars *d* and *e.*

749. *What general considerations govern the arrangement of bus bars and switches on a switchboard?*

When more than one set of bus bars are installed, it is well to provide each outgoing circuit with switches by means of which it may be connected to more than one set of bus bars; it is likewise important to be able to connect any machine to any set of bus bars. The cable plug-board is a most flexible arrangement, and for this reason is coming into extensive use for this purpose. The circuit should be grouped together in such a manner that those requiring the same potential are connected to one pair of bus bars. If some of the circuits require a higher voltage than the others, they should be kept apart and confined to one machine. Arrangements should be made so that the controlling switches, etc., in the main circuit need to be handled as little as possible.

Station Wiring

750. *What kinds of wiring are included under the head of station wiring?*

The wiring between the switchboard and the generators, and the wiring for lights.

751. *How may the conductors running between the switchboard and the generators be supported?*

One method consists in fastening them overhead to horizontal beams put in at intervals for that purpose. This arrangement is similar to that for the outside-line

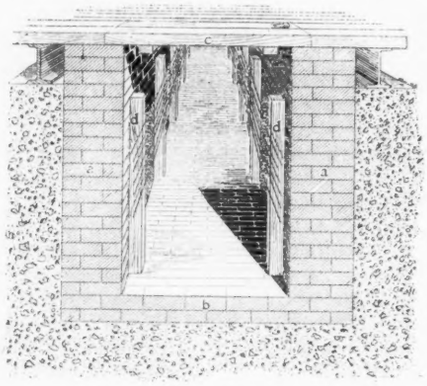


FIG. 263. A SUBWAY FOR THE STATION WIRING

method where only moderate care is exercised in doing the work. It is only necessary to support the wires on good insulators and to maintain a sufficient distance between the individual conductors. The principal objection is that there is, usually, more or less vibration, which has a tendency to shake the wires loose. This will cause them to stretch and the ties to give more or less, until in time all of the wires appear as if they had been carelessly put up.

Another method of supporting the conductors consists in running them along the walls and ceiling of the station. By doing neat work, spacing the insulators equally, avoiding kinks in straight runs, and making all curves gracefully, the installation may by this method be made to present a good appearance. One objection is that the wires usually have to be much longer to reach between the generators and the switchboard than would otherwise be the case.

752. *Are not lead-covered cables sometimes used in this work?*

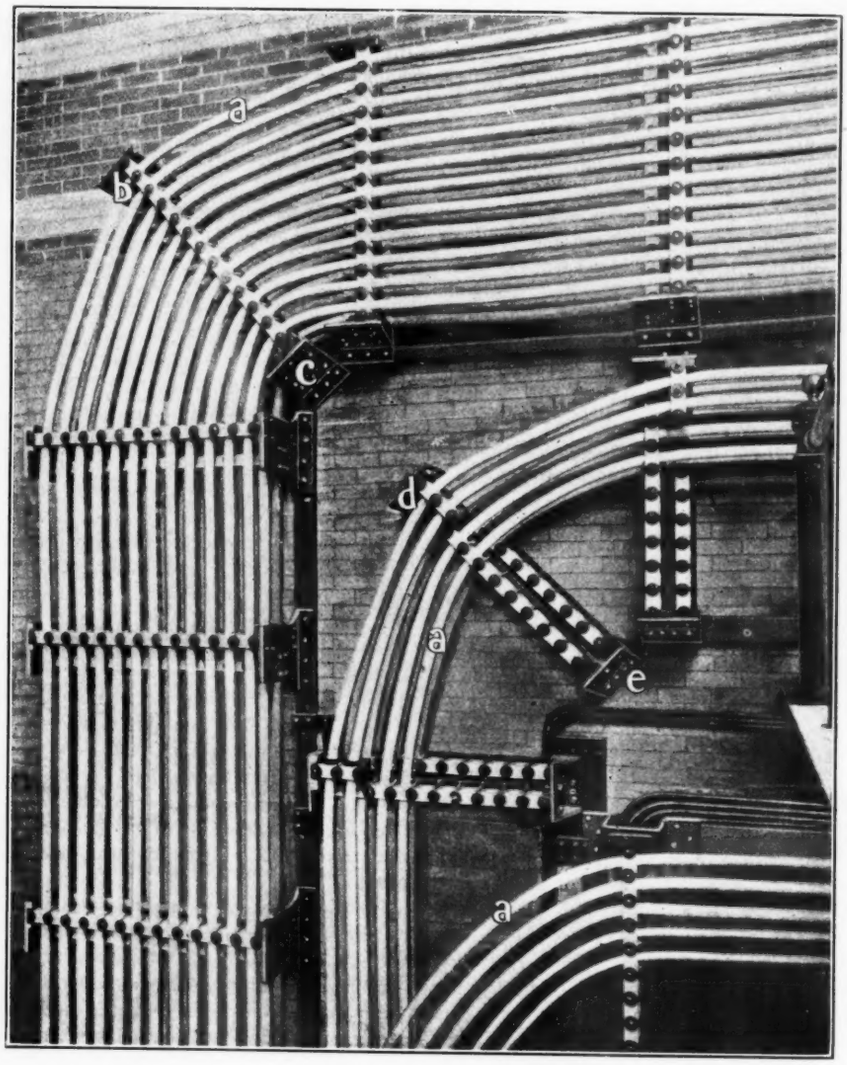


FIG. 262. METHOD OF SUPPORTING LEAD-COVERED CABLES TO THE WALL BY MEANS OF CABLE RACKS

They are used in damp locations to protect the insulation of the conductors from moisture, and where the cable is exposed to mechanical injury to protect it from

harm. In such cases the cables are usually supported along the walls by iron frames or racks, as shown at *b c, d e*, etc., in Fig. 262, where the cables may be seen at *a, a,*

By placing the conductors under the floor; there they are usually out of the way of everything, and are not apt to be interfered with.

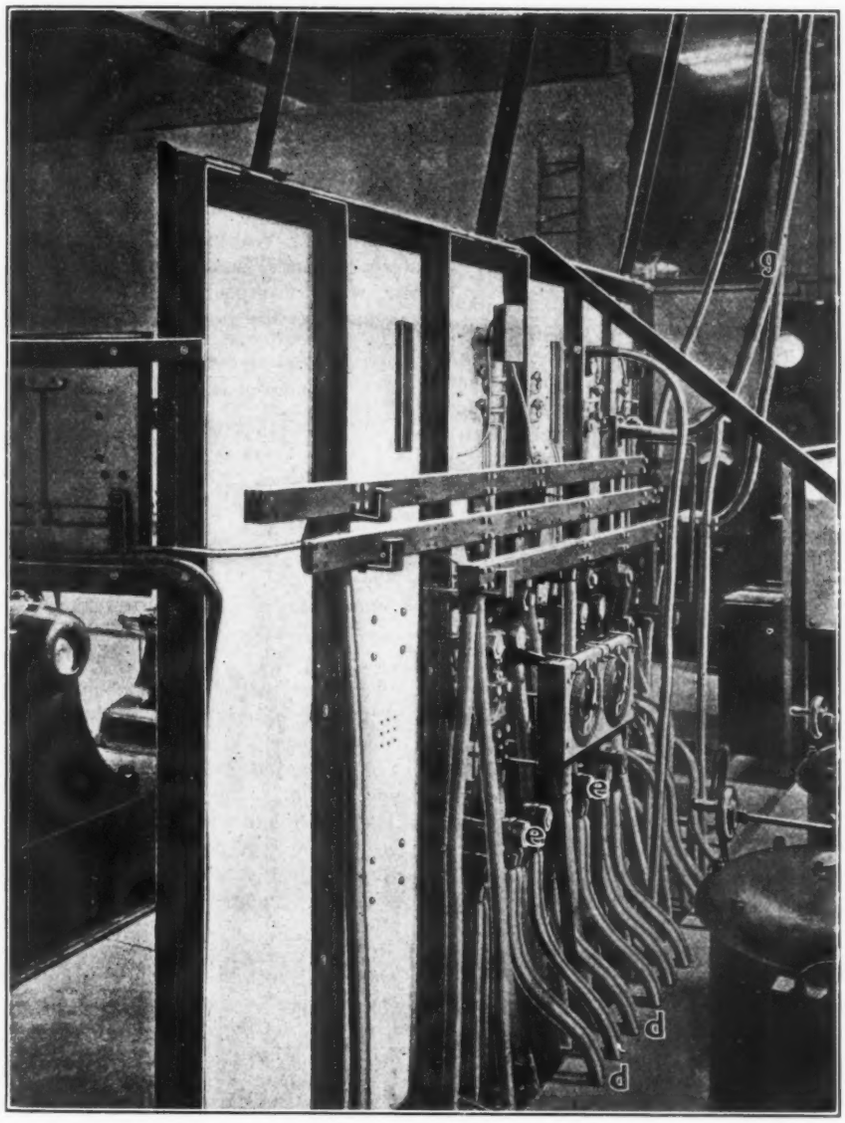


FIG. 264. BACK OF SWITCHBOACD, SHOWING HOW THE CONDUCTORS ARE BROUGHT UP THROUGH THE FLOOR FOR CONNECTION TO THE SWITCHBOARD APPARATUS

etc. The racks are securely bolted to the wall and should be of sufficient strength to safely support the weight of the cables. They may be made of any length, and can be so constructed that three or four rows of cables may be placed on top of each other. It is important that the racks be spaced sufficiently close to prevent the cables from sagging. It is also necessary that the bends formed in rounding corners be not made too short.

753. *Is there any objection to having the conductors run through the station?*

Yes; wiring in a station is likely to be in the way of a traveling crane, if there is one, and it invariably presents obstacles when repairs or changes are to be made in the plant.

754. *How may these objections be overcome?*

755. *How are the conductors arranged when put beneath the floor?*

When the building is of wood and there is space between the floor and the ground, ordinary cross-arms and insulators may be fastened under the floor and the wires supported on them. When there is no such open space, a special passage or subway under the floor may be contructed of brick or concrete; this insures protection from fire, and prevents the wires from being injured by water or other destructive agencies. When such a subway is to be used, it is best to have it included in the building contract and specifications, for that will insure better construction at less expense.

756. *How should a subway for station wiring be built?*

A simple and serviceable subway for this purpose is illustrated in Fig. 263. The distance between the walls *a* and *a* should not be less than 33 inches, but the depth may vary according to conditions. In the case shown, the depth is about 6 feet. When there are only a few conductors less space is required, and when there is a possibility of moisture accumulating there should be ample space between the wires and the floor *b*. The top may be floored or bricked over; manhole covers, as shown at *c*, should be provided at intervals. It is preferable, however, to have the cover made so that any part, or all of it, may readily be removed.

757. *How are the immediate support of the wires constructed and arranged?*

The supports *d* in the subway are made of wood, about 3 inches square. They should be well coated with an insulating and fireproof paint. The distance between the supports depends upon the kind and the size of wire to be installed.

758. *How are the insulators attached?*

The kind of insulators used determines the manner of mounting them. In the case illustrated, the wires are attached to ordinary porcelain insulators such as are commonly employed for direct-current work, and these are screwed to the uprights. The insulators should hold the wires firmly so that they cannot slide in either direction.

759. *How should the wires be installed?*

In placing the conductors in position, the reel containing the wire should be taken to either end of the run, for instance, the switchboard end; the wire may then be drawn through and fastened to the generator terminals. After having been properly tied to the first insulator at the generator end of the subway, the wire should be drawn taut all along, and securely fastened to each insulator in succession, working toward the switchboard end of the run.

760. *How are the conductors brought up for connection to the switchboard or the generators?*

Through holes in the floor, as shown at *d, d*, etc., in Fig. 264. The switchboard is shown here in course of erection, and the terminals are fastened only temporarily at *c, c*, etc.; sets of cables leading to outside lines connect directly with the switches. The generator cables are carried up close to the board, and back of these are the cables which pass through the holes *d, d*, etc., to the outside lines. Several other cables, *g*, for instance, have been placed in various positions for the purpose of completing the connections temporarily.

The engineer who continually laments that he doesn't get money enough, usually does just about enough to keep the plant from falling apart. Running a plant along the line of least work means the least pay, and grumbling will not help the case.

Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think, Know or Want to Know About Your Work, and Help Each Other

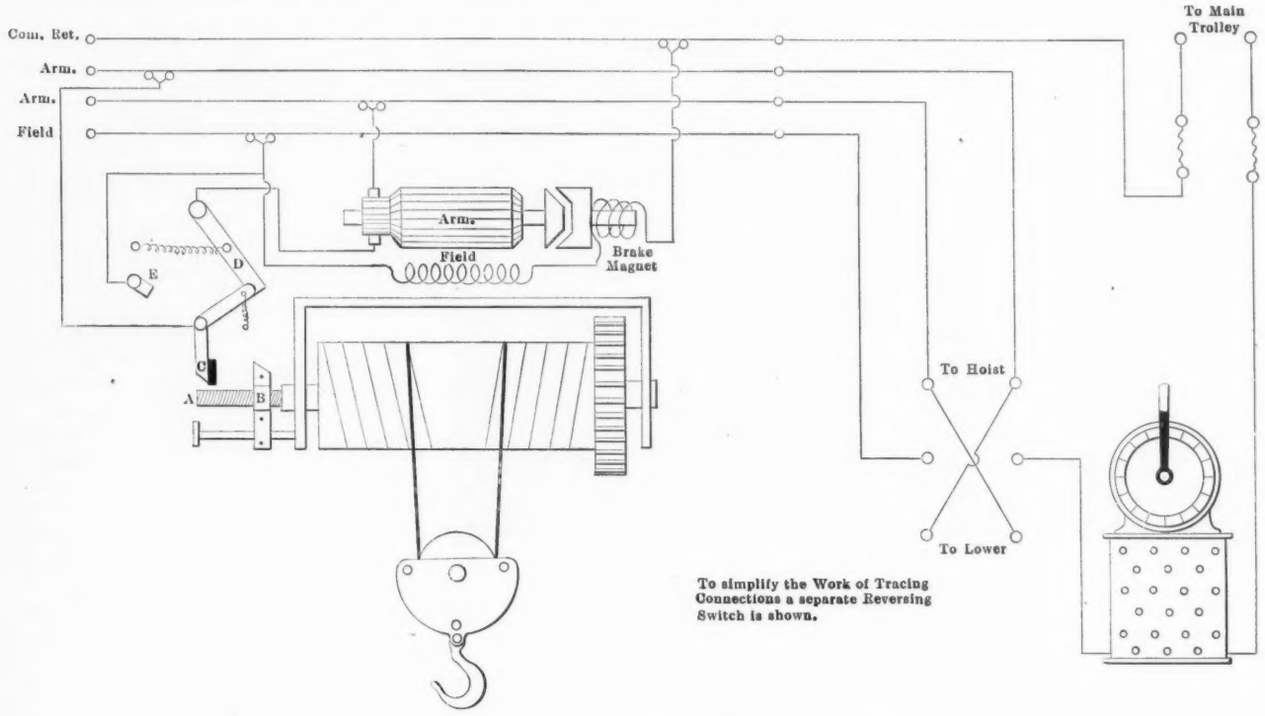
WE PAY FOR USEFUL IDEAS

A Safety Switch for Hoist Motors

The accompanying sketch shows a safety switch which I recently applied to the hoist motors of several cranes with satisfactory results. The distinctive features are that it is difficult to change the setting when once fixed and that the switch cannot be rendered entirely inoperative even if tied in by a lazy operator, the only result of such an act being to prevent the lowering of the hook until the switch has been released. Referring to the diagram, the screw *A* revolves with the drum and the nut *B* strikes the insulated trip *C* at any predetermined position of the hook. The trip releases the switch blade *D*, which is then drawn into contact with the clip *E* by the spring. A study of the connections will show that any further upward travel of the hook is prevented, but it may be lowered by moving the controller handle to the lowering position. After the hook is lowered a few feet the switch may be reset. This arrangement is also applicable to alternating-current cranes by slight changes in the connections.

R. H. FENKHAUSEN.

San Francisco, Cal.



CONNECTIONS OF SAFETY SWITCH FOR HOIST MOTORS

A Steam Reservoir

In the July 23 number, on page 137, there appears a letter pertaining to a steam reservoir, in which there are some very incorrect statements regarding the action of expanding steam. The receiver capacity is given as 9648 cubic inches and this is assumed to contain steam at 100 pounds pressure with the inlet valve closed; then the engine cylinder opens while the piston moves forward for 9 inches when cutoff takes place.

The space in the cylinder which is filled with steam contains 1809 cubic inches, and Mr. Wakeman is in error by claiming that 1809 cubic inches of steam has been removed from the receiver, leaving only 7839 cubic inches at 100 pounds pressure, which then expands and fills the receiver at 78 pounds. It is obvious, however, that this could not happen, for as soon as the engine valve opened the cylinder would act as an increasing volume to the receiver and the steam would immediately commence to expand and continue to do so until cutoff, and as the steam expands the pressure will drop; the final pressure in both the receiver and cylinder at the instant of cutoff will be the pressure to which the receiver will fall.

Taking Mr. Wakeman's assumption that steam expands according to Marrott's law, which it probably never does, then the final pressure in the receiver will be:

$$\frac{\textit{Initial absolute pressure}}{\textit{ratio of expansion}} = \frac{115 \times 9648}{11{,}457} = 97$$

pounds, absolute, or

$$97 - 15 = 82$$

pounds gage, instead of 78 pounds, as Mr. Wakeman figured it.

Mr. Wakeman also speaks of the pressure on the end of the 150-foot 5-inch steam line being 10 or 15 pounds less than boiler pressure. Surely this must be a remarkable steam line to cause such a drop when supplying less than 100 pounds of steam per minute. A drop of three pounds should be about all that a line of this size and length and under these conditions should show.

Of course, a steam reservoir is undoubtedly an advantage, but in my opinion a steam separator would be vastly superior

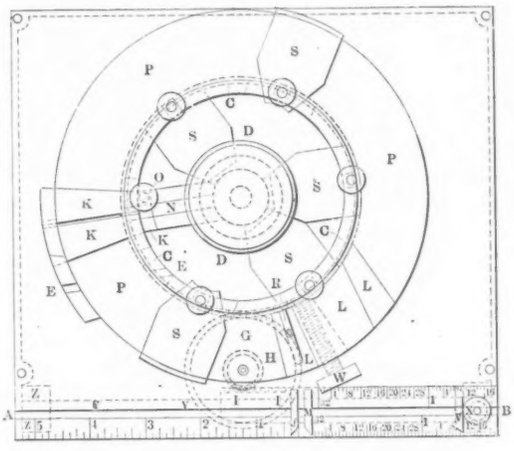
and more practical, for one can look for water under such conditions as these.

GEORGE P. PEARCE.

Exeter, N. H.

A Packing Cutter

Many engineers, instead of carrying ring packings for each individual rod, buy various widths of continuous packing and cut it up themselves. This is a good and a cheap plan, provided they have some way of cutting it to form perfect-fitting rings. I think there is a device for such a purpose on the market, and it is a pity it is not better advertised. The following describes a little machine built with small pieces of 4-inch and 1-inch pipes, and some other scraps, such as can generally be found around an engine room. The only things needing to be especially ordered are the three gears. Detailed dimensions are given, with the hope they will aid anyone desirous of constructing this handy little implement.



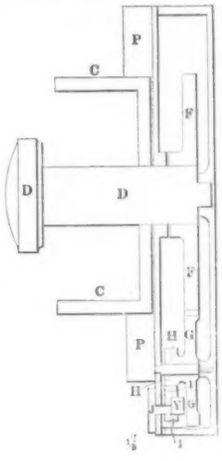


FIG. 1

The device consists of a hollow wooden box 8 3/16 feet by 7¾x1⅛ inches, a cylinder *C*, Fig. 1, of 4¼ inches outside diameter, secured to the handle shaft *D*, a cast-iron ring *P*, 1½x½ inches, outside of this, and the three gears *F*, *G* and *H*, with diameters of 4¼, 2 and 0.63662 inches, respectively. The gears *G* and *H* should be cast on one shaft, *G* meshing with *F*, which is secured to the shaft *D*, while *H* meshes with the rack *I*, which slides over the bar *Y*. To the rack *I* is secured the movable clip *J*. It will thus be seen that when the handle *D* is turned, *J* will move in the slot *A B* from or toward the stationary chip *M*. The size and arrangement of the gears are such that when *J* moves a distance equal to 1 inch on the left-hand scale, the cylinder *C* will move a distance equal to 3.1416 inches, which corresponds with the circumference of a rod whose diameter is 1 inch.

To *C* is attached the angle cutter *K*. Fig. 2 shows the outside elevation of *K*, and Fig. 3 shows the inside elevation, outside and inside of the cylinder *C*. The shell of cylinder *C* is slotted to correspond with the slot in *K*, as shown at *E*, Fig. 1. This slot guides the knife to cut the proper angle for a miter. The angle cutter *K* slides along the guide rod *N*, so as to squeeze on the various widths of packing. At *V*, Fig. 1, is a movable clip free to move in the slot to the right of the clip *M*, and can be secured in any place by a turn of the thumb screw *X*, Fig. 6.

The operation is as follows: With a pair of outside calipers measure the diameter of the rod to be packed. Place one leg of the calipers against the right-hand edge of the clip *M*, and turn the knot *D* until the clip *J* touches the other leg of the calipers. Secure it here by turning the thumb screw *W*, Fig. 1, which bears against the cylinder *C*. Then caliper the gland of the stuffing box, and place one leg of the calipers against the outside edge of the clip *J* and move the clip *V* until it touches the other leg of the calipers; *V* will now point on the lower scale to the exact width of packing required, as the scale reads 1 inch = 0.5 inch; *K* will also be in the exact position designating the required length of packing.

After cutting the proper angle on one end of the packing, place this end over the pin *R* and snugly against the angle piece *L*, Figs. 1 and 4. Then pass the packing over the cutting gage *K*, pressing it in snugly against the cylinder *C* by means of the sliding pieces *S*, Fig. 5, which can be secured by the thumb screws shown. Slide *K* in against the packing, and with the slots *E* to guide, and with a sharp knife, the proper angle is cut.

The packing will now fit the rod perfectly. In some places the gland is so worn that it is necessary to caliper the inside of the stuffing box to obtain the right width of packing. In this case use the inside edges of the clips, and use the upper left-hand scale.

R. O. RICHARDS.

Framingham, Mass.

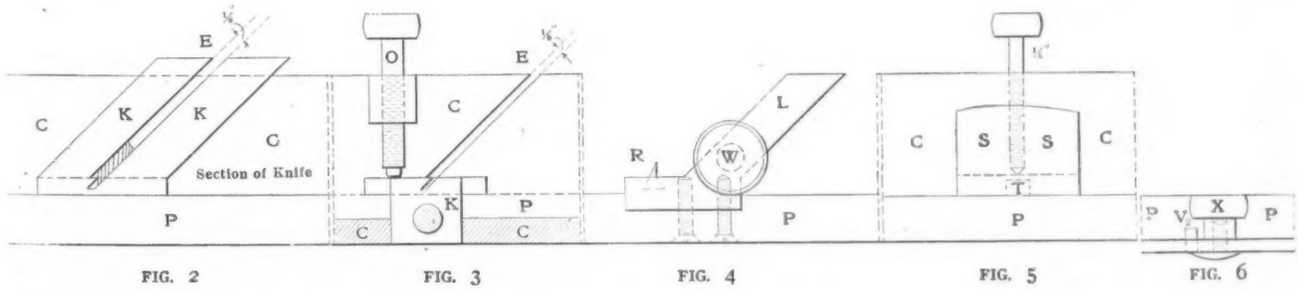


FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6

The Lake Lifts Itself

Replying to J. E. Bates' problem under the above caption, in the July 28 number, it is evident that the bottom of his well is in a layer of gravel having an outlet at some point more than 18 feet below the surface of the lake; and if a large hole should be made from the lake into this layer of gravel, the lake would rapidly drain into the pit.

I have seen this apparent impossibility several times in gravel excavations near ponds or rivers where the water had very little flow. The explanation can be found in the fact that in all still-water ponds or sluggish streams the gravel banks are coated with a layer of mud, which is largely composed of vegetable matter impervious to water.

There is another peculiarity of this pond lining, which he has not had occasion to notice; that is, it acts like a check valve. Ground water can flow into the pond by pushing away the layer, like a flap valve, but pressure from the inside only packs it the tighter. It is on this principle that dams are built of loose rocks covered on the upper side with a layer of fine material and sod, the loose rocks forming the strength of the dam and the fine material and rocks making a waterproof blanket on the pressure side.

OTIS D. RICE.

Winthrop, Mass.

What Caused the Pound

I note with interest Mr. House's solution of Mr. McCann's trouble in Aug. 18 issue, and would like to ask Mr. House to explain how he finds the clearance of an engine from the indicator card. I think it would be of interest to engineers in general.

ALEXANDER WELDON.

W. Fitchburg, Mass.

In the July 28 number, page 151, William McCann asked what caused the pound in his engine. I am under the impression that his engine needs lining up. The indicator cards show that the valves are set economical and also that there is a good steam distribution. I advise Mr. McCann to see that his flywheel is keyed to the shaft, and all of the reciprocating parts are properly lined up and the piston have equal clearance on both ends.

J. E. STROTHER.

St. Joseph, Mo.

In reply to what causes the pound in William McCann's engine, I am of the opinion, judging from the diagrams, that he has not compression enough.

I always set my exhaust valves to obtain a compression of one-half the boiler pressure and I have smooth-running engines.

GUY CONLEY.

Paris, Ark.

Replying to Mr. McCann's trouble with his Corliss engine pounding, I should say by the looks of the card shown, that the release on both ends is late. I also notice that there is not enough compression.

Give the exhaust valve a little more laps, so as to close earlier, which will give more compression.

ALBERT SMITH.

Barrytown, N. Y.

Wear of Wrist-Pin Brasses

In the July 21 number, on page 117, I think J. A. Carruthers must have got his wrist pin mixed with the crank pin; at least, my experience has been the opposite of his. I have had Corliss engines, ice machines, air compressors and high-speed engines which always needed wrist-pin more often than crank-pin adjustment.

I have now four high-speed self-oiled engines which need wrist-pin adjustment three times to one of the crank pin; a two-stage air compressor on which the wrist pins wear three times as fast as the crank pin; a 50-ton ice machine on which we babbitt the wrist pins twice a year, while the crank pin has only been babbitted once in ten years. Both the wrist-pin and crank-pin boxes contain the same kind of metal.

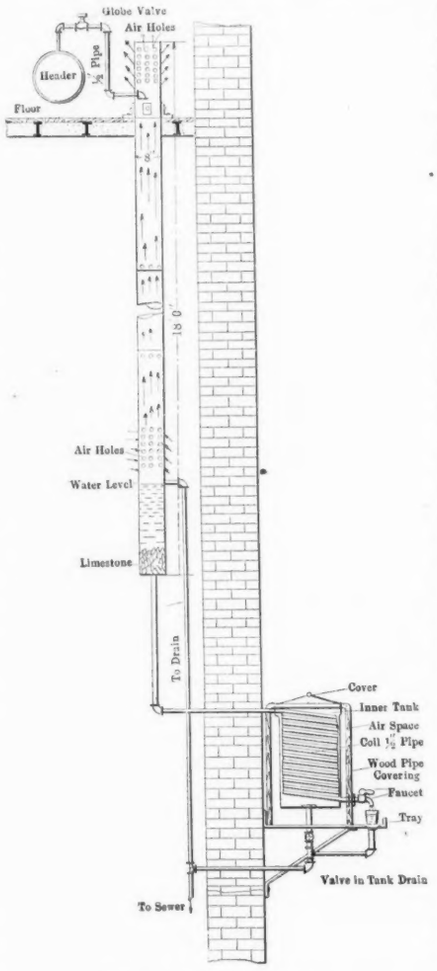
On an air compressor which we discarded a year ago the boxes were babbitted on the crank end, but on the wrist-pin end they were of solid brass; these wore much faster than the babbitted boxes.

WILLIAM SCHOCH.

Bryn Mawr, Penn.

Device for Purifying Water

The following is a description of a device which will be a boon to any engineer where the drinking water is not pure. The plant where this device is used takes water for its boilers and condensers from



WATER-PURIFYING DEVICE

a river receiving the sewage from a city of 8000 population 1½ miles up the stream.

From the top of the 15-inch header back of six upright boilers, a ½-inch pipe is tapped, to which is fitted a globe valve. This pipe leads to the top of a galvanized-iron pipe 8 inches in diameter by 18 feet long, which is riveted and soldered at the joints. It is supported by iron brackets at the top and hangs down through the floor, under the header. About 2 feet of this pipe extends upward above the floor and is fitted with a cap. At the top above the floor are punched several rows of ¾-inch holes, leaving a bur sticking inside to keep the water from working out when condensation goes on inside.

About 3 feet from the lower end of the pipe, the bottom of which is riveted and soldered, is a second group of holes, below which is an overflow pipe connected with the sewer. In the bottom of the condenser is a ½-inch pipe running down and through a brick wall into the engine room.

In the bottom of the condenser is a quantity of limestone which relieves the water of a flat taste. The steam flowing through the globe valve in the pipe leading from the header enters the condenser below the upper set of holes and is turned downward. The valve is opened enough to allow steam to condense and run down inside and not blow any out. The heat of the steam creates a draft in the condenser and draws air from an open window into the lower holes and out through the upper set of holes, which helps to condense and cool the water.

In the engine room is a galvanized-iron tank 30 inches high and 20 inches in diameter. Hung inside this tank is a smaller one having a clearance of 1½ inches at the sides and bottom. This space is insulated and heat cannot get in. At the top is a galvanized-iron cover, lagged inside with wood and extending over the top, the wood fitting close inside. The top and sides are covered with magnesia pipe covering, which is covered with muslin and white paint. Several strips of tin, ¾-inch wide, are wound around the whole and, when treated with shellac, look like brass. The tank is set in a shallow tray, held up by brackets. Inside of the inner tank is 38 feet of ½-inch pipe, coiled just small enough to slip inside. The upper end of this coil runs through the upper part of the tank and connects with the pipe leading from the condenser. The lower end of the pipe runs to a nipple soldered into both tanks, and is coupled to the nipple inside with a union. The outside is connected to a faucet.

A drain pipe runs up through the bottom of both tanks and joins a tee 1 foot below the tray. From this tee a branch runs up to the tray, and under the faucet is perforated a depression below the level of the tray.

From a tee where the tank and tray drains join, a pipe is run through the brick wall and joins the overflow pipe from the condenser, all three being drained through one pipe to the drainage ditch in the boiler room.

The coil holds about three quarts of water. The ice lasts well and the water with the ice gets all the heat out of the coil, and after the ice is gone, there is still several gallons of ice-cold water to be warmed up before the drinking water is spoiled.

CHARLES M. GREEN.

Conneaut, Ohio.

Burning Soft Coal Screenings

On page 198, August 4 issue, James E. Noble asks for information on burning soft-coal screenings, and as I have had a little experience along this line, I will give it for what it is worth.

The first boiler we tried it with was of the horizontal return-tubular type of 80 horsepower. The grates were of the herring-bone pattern and the spaces were about ¼ inch wide. The furnace was about 2 feet from the lowest part of the boiler and the bridgewall was only about a foot away. The screenings were of the poorest grade soft coal and were all the way from buckwheat size to dust—mostly dust.

I shall never forget the first day we tried to burn this stuff; we started in with the usual run-of-mine bituminous coal until about 10 a.m., and then switched to the screenings. The first shovelful or so caused no apparent difference in the furnace, but soon the fire began to lose its brilliancy and the steam began to drop, for this boiler was worked hard. The fireman put on full draft and scattered the screenings in nice thin, even layers, but the fire quickly died down and by 11:30 a.m., we had to shut that part of the plant down for lack of steam, even though we had returned to the regular fuel.

We decided not to make such a sudden change again, but try and work the screenings in with the run-of-mine coal in increasing proportions as the firemen got more used to burning it; however, the best we ever got was about half-and-half, and even that was risky, for if once the fire started going down nothing but plenty of firewood and a quick change to regular fuel would save it.

I might mention here that the stack was only 37 feet high and that the fireman was a very successful one who could get results where others could do nothing. We eventually came to the conclusion that forced draft would be necessary before it would be practical to burn this stuff, and so a 16-inch fan was installed. This gave a very powerful blast in the ashpit, which ordinarily would blow all the coal and the grates pretty nearly up the chimney if we had not had a damper to regulate it. This arrangement made quite a difference in the results, and we slowly increased the percentage of screenings until we were burning them altogether with complete satisfaction. We also discovered that screenings had to have a special method of handling before they would burn at a satisfactory rate, and the following is an outline of the instructions given to the firemen:

Start the fire with the run-of-mine coal and get a good hot fire and the steam right up before attempting to use the screenings.

Throw the screenings in small shovels full onto what appear to be the thinnest places in the fire and open the blast damper slightly.

Don't on any account poke, rake or slice the fire, but let it burn; if it should cake over hard in any place the cake can be carefully broken, but must not be turned over or moved about.

Keep putting the fuel on the places where thin spots appear or where it is burning hardest and as the thickness of the fire increases put on more blast.

About one-half hour before noon start in burning run-of-mine coal and as soon as the whistle blows start in to clean fire, which will now be about 10 or 12 inches thick.

To clean out, push the top burning fuel on one side and then draw everything else out, then change sides and clean out again; feed with run-of-mine coal and put on slight blast so as to have a good fire and steam up before the whistle blows.

After starting up and running for 10 or 15 minutes start in with screenings again.

At night completely clean out fire and bar off all clinkers and dross from the grates.

This is what experience taught us, and we could not make a success of it any other way. We also used to burn these screenings on other boilers that were equipped with shaking grates, but we found that it was best to follow the above directions up to the quitting hours, when instead of drawing the fires, they could be shaken down. This made it far more comfortable for the firemen. About one-third unburnt coal would come out when the fires were drawn; we saved some of this by screening and put it in the furnace again. By whistle time the blast would generally be onto its full pressure and then would only be just enough; this was obviously due to the extreme thickness the fire had built up to—sometimes reaching 14 inches. If a fireman "lost his fire," that is, got it down a little or thoughtlessly stirred it up so as to mix the screenings with the ashes, it almost always meant drawing the fires and starting again.

This system was in use for about two years, but finally it seemed as though the game was not worth the candle, for while it certainly made a cut in the coal bills, yet it did not take many shutdowns to overbalance that, and if a fireman was off we could not take a green one for this work, as it took nearly a month before a fireman got broke in satisfactorily. All the firemen kicked about it, as it meant such close attention all the time, and altogether in the eyes of all it was a troublesome proposition.

Of course, I do not wish to be understood as condemning this system, for if the price is right and the conditions right it undoubtedly will save in cost, and there are probably other and better ways of handling this of which I have never heard.

GEORGE P. PEARCE.

Exeter, N. H.

Wants to Know How to Build a Filter

I have been trying to build a water filter so that I might use the water from the river in our plant instead of town water. I do not wish to make the water pure enough to drink, but as the water in the river has a reddish color, I would like to have the water as clear as possible.

We are using between 12,000 and 15,000 gallons of water per day, and if I could utilize the river water it would make quite a saving in our water rates.

L. W. COLVIN.

Bridgewater, Mass.

Trouble on a Trolley Circuit

In the June 23 number, there is a letter by M. A. Hamilton with reference to trouble on a trolley circuit, and G. S. Glick answered in the July 28 issue in a way which would intimate that he did not understand the proper connections of the wattmeter, or he would not state that it was possible to determine the line loss from his readings.

If the wattmeter is properly connected with the current coil or coils in either the positive or negative side of the line, and the voltage coils directly across the line at the switchboard, this machine will record the actual output of the generator, regardless of the line loss. It would be interesting to know which side of the circuit is connected to the trolley on Mr. Hamilton's road, as it is usual to put the circuit breakers on the positive side and to run the positive side to the trolley, putting the ammeter and current coil of the wattmeter on the negative side.

There is a possibility that Mr. Hamilton's trouble comes from having to run three generators a very considerable portion of the time, the trouble coming from the influence of stray fields upon these wattmeters. If there is but one wattmeter on the line and the leads from the generators run close to it, the stray field set up may seriously influence this machine and make it run very slowly. If each generator has a wattmeter, the influence of the stray fields from the line and from the other two generators may also influence it.

I believe it would be well worth while for Mr. Hamilton to submit a wiring diagram of the conditions at his station, stating the type of wattmeters in use and showing distinctly the location of all the leads carrying generator or line current with reference to the wattmeter.

HENRY D. JACKSON.

Boston, Mass.

Drop of Voltage Due to Inductive Load

Having read on page 238 of POWER AND THE ENGINEER, Aug. 11, issue, George C. Woodworth's statement of the trouble he is having in maintaining normal voltage on his generators due to the fact that they are operating on a highly inductive load, I beg to offer the following suggestions:

He states that he has a 75-kilowatt belted-type generator and one of 150 kilowatt capacity direct-connected to an 18 by 18-inch Ball engine running at 225 revolutions per minute, which would indicate that this is a 32-pole, 60-cycle generator. Both of these machines have their fields excited from direct-connected exciters running at the same speed as the generators.

If with the three phases balanced, that is, with the current equal in all three lines, and with the machines running up to normal speed, the voltage cannot be maintained, there are two methods of remedying the trouble.

First, we may install additional apparatus, which may be a new generator or a synchronous motor having a capacity for leading current equal to the lagging current required by the inductive load (induction motors in this case). The leading current taken by the motor can be regulated by adjusting the excitation of the field and be made to neutralize the lagging current required by the load, thus giving unity-power factors on our generators. Low-power factors, due to lagging current, not only increase the current in the armature required for doing a given amount of work, but the lagging current, which is the cause of the low-power factor, demagnetizes the field cores thus requiring an increase in the field current in order to maintain normal voltage under these conditions.

Second, we may make some change in the design of the exciter so as to increase its voltage, or we may increase the size of the conductors of the field winding on the generator so as to decrease the excitation voltage; instead of altering either of these, we may shim up the poles on the generator, thus reducing the air-gap, and consequently the field current required for maintaining normal voltage under the existing load.

The question arises at once, which of these methods will give satisfactory results with the expenditure of the least amount of money? There are several points, such as the power required by the load, the power factor at which the electrical energy is to be supplied, the importance of voltage regulation in the operation of the plant, the heating of and the excitation voltage of the generators already installed, which must be considered in deciding which method of procedure will be best, all things considered. To illustrate we will take the case given as a concrete example:

Suppose that the load which consists of lamps and induction motors required 225 kilowatts of actual energy at 70 per cent. power factor or 322 kilovolt-amperes of apparent energy. If the generators at present installed (225 kilowatts capacity), are carrying 225 kilovolt-amperes at, say, approximately 70 per cent. power factor, and are running cool, the only trouble being that the exciters do not give a voltage high enough to supply the exciting current required, it may be feasible to alter the design of the exciter or of the generator field as noted above so as to give a more liberal margin on excitation voltage, and thus enable the load to be handled easily with the present equipment. If the voltage regulation of the generators is low and if there are no objections to having it higher, the poles on the generator may be shimmed up, thus reducing the air gap and the excitation current and voltage from 15 to 30 per cent. depending, of course, upon mechanical clearance desired and the allowable increase in regulation. This will also result in reducing the heating of the field and can be done at a small cost.

If the reduction in the air gap is not allowable, and if the heating of the generator field and the exciter armature will permit it, we may put new field coils on the generator having a larger sectional area and lower resistance, thus enabling the exciter voltage to force a larger current through the field winding. This will increase the heating of the generator field and the exciter armature and will be a more expensive remedy than the first.

Again, we may decrease the air gap on the exciter or reduce the resistance of its field winding thus enabling it to generate a higher voltage. (In the case of belted exciters, we may change the pulley ratios and thus increase the speed and the voltage of the exciter, which remedy is not available in this case however.) This will usually be cheaper than changing the generator field winding, but there are many small exciters built which do not admit of a change in the air gap. If the generators already installed are limited in capacity due to heating, and will not permit of slight changes in design so as to increase their capacity for carrying inductive loads, and it becomes necessary for us to install new apparatus, which will give the best results for the least money, a new generator or a synchronous motor?

If the inductive apparatus is located at the end of a long transmission line with the generators at the other end, it will usually, if not always, be cheaper from the standpoint of money invested in generators and line material, and a great deal more satisfactory as regards voltage-regulation of the system, to install a synchronous condenser of economical design at the receiver end of the line, thus reducing the volume of current in the line as well as in the generators.

In this particular case, however, where there is evidently no long line a synchronous motor if installed simply to run idle on the system for neutralizing lagging current would be more expensive than additional generating apparatus which would give the same ultimate actual power capacity. To illustrate, in the present case we have, say, generators having a capacity of 225 kilovolt-amperes at any power factor from 70 to 100 per cent., and we desire to feed 225 kilowatts of actual power to an inductive load having a power factor of 70 per cent. or 322 kilovolt-amperes apparent energy. We would require a synchronous condenser having a capacity of 225 kilovolt-amperes leading current to neutralize the lagging current required by the load, thus maintaining unity-power factor on the generators. If we were to install an additional generator having a capacity of 97-kilovolt-amperes at any power factor from 70 to 100 per cent., we would have the same actual power capacity, i.e., 225 kilowatts, available that we had by the addition of a synchronous motor having a capacity of 225 kilovolt-amperes or 2.32 times as large as the generator. Of course, if the generator is of the slow-speed engine type, it may cost as much or even more than the high-speed motor, besides we have the benefit of low voltage regulation and cool generator fields in case we choose the synchronous motor in preference to the additional generator.

In the present case it would seem advisable to take some temperature readings on the machine after a run of several hours at the highest load at which the voltage could be maintained at its normal value, and determine just how hot the machines were getting at this load. These temperatures may go as high as 40 or 50 degrees Centigrade above the room temperature of 25 degrees Centigrade (77 degrees Fahrenheit) without cause for alarm, or in other words, if a thermometer placed on any part of the machine does not show a reading greater than 70 degrees Centrigrade (158 degrees Fahrenheit) all is well. If the temperatures are considerably less than these, it would be advisable to make some of the above changes in the design of the machines which would enable the present machines to carry the large lagging current and still maintain the voltage.

As to the advisability of removing the belt from the 75-kilowatt machine, and running it as a synchronous condenser, we note the following:

If this machine has short-circuiting collars around the poles it may operate satisfactorily without hunting and consequent breaking down of the insulation of the field winding. The fields of machines designed for operation as synchronous motors usually have a great deal heavier insulation than generators so as to prevent

short-circuits due to the high induced voltages in the winding when starting from rest or when hunting occurs during operation. In addition to the extra insulation, a metal short-circuiting collar is usually placed around the poles under the tips so as to reduce the voltage induced in the field winding.

If you are having trouble in maintaining the voltage on this generator when operating 75 kilowatt-amperes at, say, 70 per cent. power factor, you will not be able to get more than about 65 kilovolt-amperes of leading current at approximately zero power factor when operating as a motor. Hence, if you run both generators on the system you will be able to deliver 225 kilovolt-amperes at 70 per cent. power factor or 157.5 kilowatts of actual power to the load, while if you run your 74-kilowatt generator as a motor and obtain only 65 kilovolt-amperes of leading current, you will be able to raise the power factor on your 150-kilowatt generator from 70 per cent. to 89 per cent., which will enable this machine to deliver 133.5 killowatts of power to the load. In other words, the power which can be delivered by the 150-kilowatt generator alone with the 75-kilowatt machine operating as a motor will be only 85 per cent. of that available when the two machines are operated as generators.

Third, the power required to drive the motor when operating under full load leading current (75-kilovolt-amperes) will be somewhere in the neighborhood of 5 of 6 kilowatts or 7 or 8 horsepower.

Mr. Woodworth states that he has run this machine as a motor up to normal speed, but cannot get the voltage at its terminals up to normal. If the generator supplying power for driving the motor were not already overloaded, it would indicate that there was a very weak field or none at all on the motor which caused it to take a large lagging current at a low power factor which demagnetized the field of the generator, thus reducing the voltage.

I would suggest that he observe the field current required by this generator to give normal voltage when on open circuit, and that he excite the field with this same current when it has come up to synchronous speed as a motor which ought to cause it to take a minimum running light current in phase with the terminal voltage. The field current should be varied either side of this value and the current taken by the armature observed. There will be a value of the field current which will give a minimum armature current and if the field current is increased above or decreased below this value, it will cause the current taken by the motor to increase. When running light with this value of field current the motor is taking current at unity power factor.

The power required to drive the motor under this condition is that consumed in overcoming the internal losses of the motor, namely core loss, bearing friction, windage and a small amount of I^2R loss in the armature. The I^2R losses in the field of the generator and the internal losses in the exciter have to be added in this case since the motor is driving its own exciter. These losses will probably be about 4.5 kilowatts for a machine of this size. We may now increase our field current until normal current is flowing in the armature or until the full exciter voltage is impressed across the terminals of the motor field which we might note is obtained by cutting out all the resistance in the exciter field. The internal losses or power required to drive the motor will now have increased from 4.5 up to, say, 5 or 6 kilowatts, due to the increase in the I^2R losses in generator and exciter armatures and fields and also due to the increased core loss in the exciter armature.

F. C. HELMS.

Schenectady, N. Y.

In regard to Mr. Woodworth's trouble, on page 238 of the August 11 number, with his plant, I will say that, although it is advisable to use a synchronous motor and over-excite the same so as to get a leading component of the current, to neutralize the lagging component and also to raise the power factor to unity and reduce the armature reactance, it is not very often that one is used for that purpose, especially in a plant of his size. The power factor of his system with the load he mentions should be at least 80 per cent. without the use of any compensating apparatus. I judge that there are a number of induction motors on the circuit that are either too large for the work or else the motors are running a large part of the time on a small portion of the normal load they have to carry. An induction motor under these conditions would reduce the power factor and it would not take many acting in this way to make the current lag so much as to make it very noticeable on the generator, especially on the system of the capacity mentioned. But if it is found necessary to use the synchronous motor for the purpose, all that is necessary is to parallel it with the alternator driving it and then over-excite the fields of the motor until the power factor indicator shows unity. Of course it is necessary to help the adjustment within the limits of the machine.

The reason Mr. Woodworth could not get the voltage up if he connected the small machine with the large one, so as to bring it up to speed is because there was not enough magnetizing current in the motor field, and in this case it would cause a lagging current to flow in, and this current acting with the low-power factor load, made matters worse, on account of the extra armature reactance on the alternator. It is probable that the exciter voltage was not high enough to send the required current through the field of the alternator to bring the voltage up to normal under this condition.

The small alternator is all right for the purposes if used in the proper way, and the power required to run it would be just the amount necessary to overcome the electrical losses and the mechanical friction.

JAMES E. KILROY.

Lincoln Place, Penn.

Experience with a Marsh Pump

In reply to H. N. Stanfield's article on page 668, it is customary in mines where ventilation permits to place the exhaust from the pump in the sump and condense it. The writer has had experience with pumps of the size mentioned, and larger ones, where the exhaust was placed in the sump, and found no trouble with oil in the water. Some engineers claim that the oil is held by the rock on the bottom and sides of the sump, but I have never noticed any oil clinging to the surface of the rocks in my experience.

E. E. WEBSTER.

Prescott, Ariz.

How Should Gas Be Metered and Charged For?

Replying to G. W. Felver, on page 113 of July 21 number, I am of the opinion that he must have missed J. O. Benefiel's letter on page 748 of the May 12 issue, where he backs up my statements and gives a table of factors, which, multiplied by the meter reading, give the true amount of gas when the pressure is higher than four ounces above atmospheric pressure.

I cannot see the reasonableness of Mr. Felver's argument. He states that he believes gas and steam should come under the same head in this respect and asks me if I would "be willing to pay for the expansion of steam from a 1½-inch pipe to a 2-inch pipe, under the theory that it would produce more power after expansion."

I do not believe in any such theory, and I did not so state. I hold that gas and steam should come under the same head, and if I made a contract to use steam by meter, my bargain being so much per cubic foot delivered under 50 pounds pressure per square inch, and the supply company, for some reason, had delivered it at 100 pounds pressure, then I would be willing to pay double the amount per cubic foot for the high pressure steam. Why? Because every cubic foot that came through the meter at 100 pounds pressure would, when it came to my reducing valve, expand into two cubic feet of steam at 50 pounds pressure.

DANIEL C. CHITTENDEN.

Brantford, Ont.

Riding Cutoff Valve

The riding cutoff valve of an old style consisted of a main slab valve with steam slots at each end, and a plain, flat valve without ports riding back and forth on the top of it, cutting off the steam according to the position of the rider eccentric, as shown in Fig. 1.

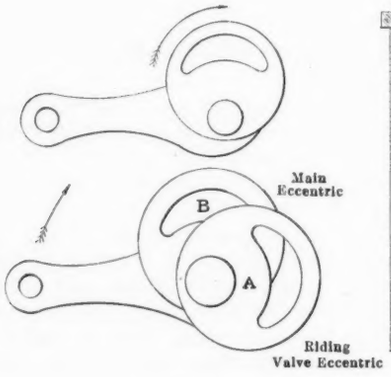


FIG. 1

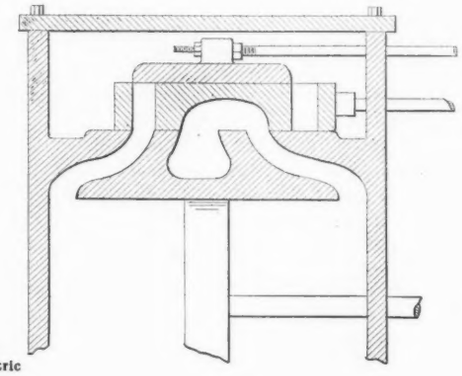


FIG. 2

The riding cutoff shows quite an improvement in expansion over the simple D slide valve. No engineer should think of going before an examiner for a license without being familiar with this old-style riding cutoff valve, as when it is once mastered he has the fundamental principle of all valve setting. With the single slide valve it is not feasible to cut off earlier than at 5/8 or 3/4 stroke, because of excessive compression and too early release, but the riding cutoff changes these conditions. With a lapless main valve and the eccentric set at 90 degrees, by shifting the riding-valve eccentric forward or backward, any desired point of cutoff may be obtained. The main valve governs the admission compression and release. If the riding-valve eccentric is fixed as in the position *A*, Fig. 1, or 90 degrees ahead of the main eccentric *B*, or 180 degrees ahead of the crank, when the piston started on the stroke and the main eccentric opens the main valve, the riding-valve eccentric, moving in an opposite direction, moves its valve so as to close the steam port through the main valve. When the piston reaches half stroke, the edge of the riding valve and the outside edge of the steam port in the main valve are as shown in Fig. 2, cutting off the steam. The more this riding-valve eccentric is advanced the earlier in the stroke will it meet and cut off the port opening of the main valve, the cutoff depending upon the angle of advance of the riding-valve eccentric which can be set to obtain any desired cutoff.

In Fig. 4 will be seen a riding cutoff valve with the rider valve in two pieces. By turning the handwheel on the end of the steam chest the halves of the rider are separated, which is the same as adding a lap to the riding valve and cutting off the steam earlier in the stroke.

In Fig. 3, *A* represents a closed box for holding the riding- and eccentric-valve stems, and to allow the stem to be turned around. The valve stem is threaded with right- and left-hand threads. The handwheel *B*, shown as an end view, is also fitted to the valve stem outside of the steam chest. This valve stem has a long keyway in which is fitted a feather attached to the handwheel. When the handwheel is turned the riding valve will be lengthened or shortened and the point of cutoff changed. The point of cutoff can be determined by taking off the steam-chest cover, turning the handwheel, and noting how many turns it requires to completely cut off the steam. By this method it can be told how much difference one turn will make on the riding valve, and about where it will cut off for a certain number of turns. The cutoff should not occur later than at one-half stroke, except in extreme cases, because the riding valve will reopen the port before the end of the stroke, and before the main valve is closed. For setting, the halves of the rider should be screwed together at the start and after that the following rule pertaining to the regular riding cutoff valve should be followed: In setting the valve, set the main valve exactly as though it were a single slide valve, by turning the eccentric around on the shaft, and see if the main valve opens the head-end port the same as the crank-end port. If it does, the main valve is squared. Next, put the crank on either center and advance the main eccentric until the port on the crank end shows 1/16 inch lead. Put the engine on the other center and see if the lead is the same; if not, adjust one-half of the difference on the valve and one-half on the eccentric.

Next, place the riding valve so it will be in the position shown in Fig. 4, exactly between the ports, and put the riding-valve eccentric even with the main eccentric. The engine will then run as a simple slide-valve engine. Then advance the riding-valve eccentric until it is just opposite the crank, or at 180 degrees, giving a cutoff at one-half stroke. Then put the crosshead out as many inches as it is desired to cut off at, and throw the riding-valve eccentric ahead until the riding valve just closes the port in the main valve. Then turn the engine to the other center and put the crosshead out the same distance and see if it cuts off the same; which it will not do, because of the angularity of the connecting rod; as in the case of the main valve, the difference must be divided, changing one-half on the valve and the other half on the riding-valve eccentric.

For instance, observe where the cutoff is on the head end and then on the crank end and see how much the port lacks of closing on one end. Then move the valve on the rod until it is one-half this distance and reset the eccentric to the point of cutoff decided upon. To get exactly equal cutoff on both ends the valve will have to be changed slightly for each cutoff. To get a later cutoff, move the eccentric back on the shaft, and to get earlier cutoff, move the eccentric ahead. After this, do a little adjusting to make it exact, but do not put the riding-valve eccentric back to get cutoff much later than at one-half stroke, owing to the liability of the rider valve reopening the port before the main valve port is closed.

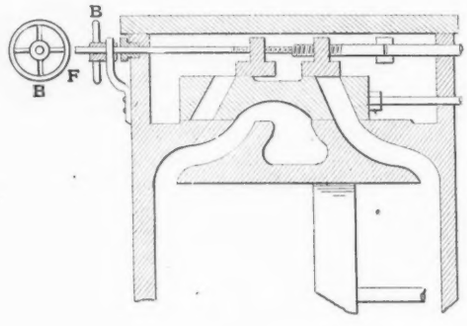


FIG. 3

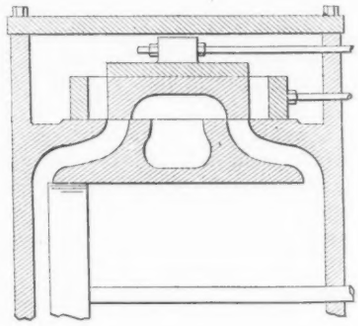


FIG. 4

A. C. WALDRON.

Lynn, Mass.

A New Type of Water Wheel Governor

Description of an Oil-pressure Governor Recently Brought Out, and Which Combines the Best of Domestic and Foreign Practice

BY SIMPSON RICE

Hydraulic turbines of large capacities, operating under high heads, present to the engineer of today problems that a few years ago were either unthought-of or conveniently ignored, and conspicuous among these is the subject of speed regulation. The first of the hydro-electric plants of this country to be put in successful commercial operation might be grouped under three general classes:

(1) Low head developments where water was brought in an open flume to reaction turbines.

(2) Similar plants having a closed flume and short penstock.

(3) Medium head developments using impulse wheels.

In the case of (1) and (2), with a sudden change of load, even from full load to no load, or the opposite, there was hardly any change in the velocity at which the water entered the turbine—at least not enough difference to be appreciable—for the reason that the normal velocity of the water under such low heads seldom exceeded 2 to 3 feet per second; while, with the use of impulse turbines, the velocity of the water in the flume or penstock was not varied by such changes, all fluctuations of load being provided for, either by deflecting part of the water from the wheel, sufficiently to compensate for the change in load, or obtaining the same result by means of a bypass operating in synchronism with a needle or tongue nozzle. A fairly good regulation could ordinarily be obtained, provided the governor were powerful enough to operate the gate mechanism, this feature being more or less complicated by the various types used.

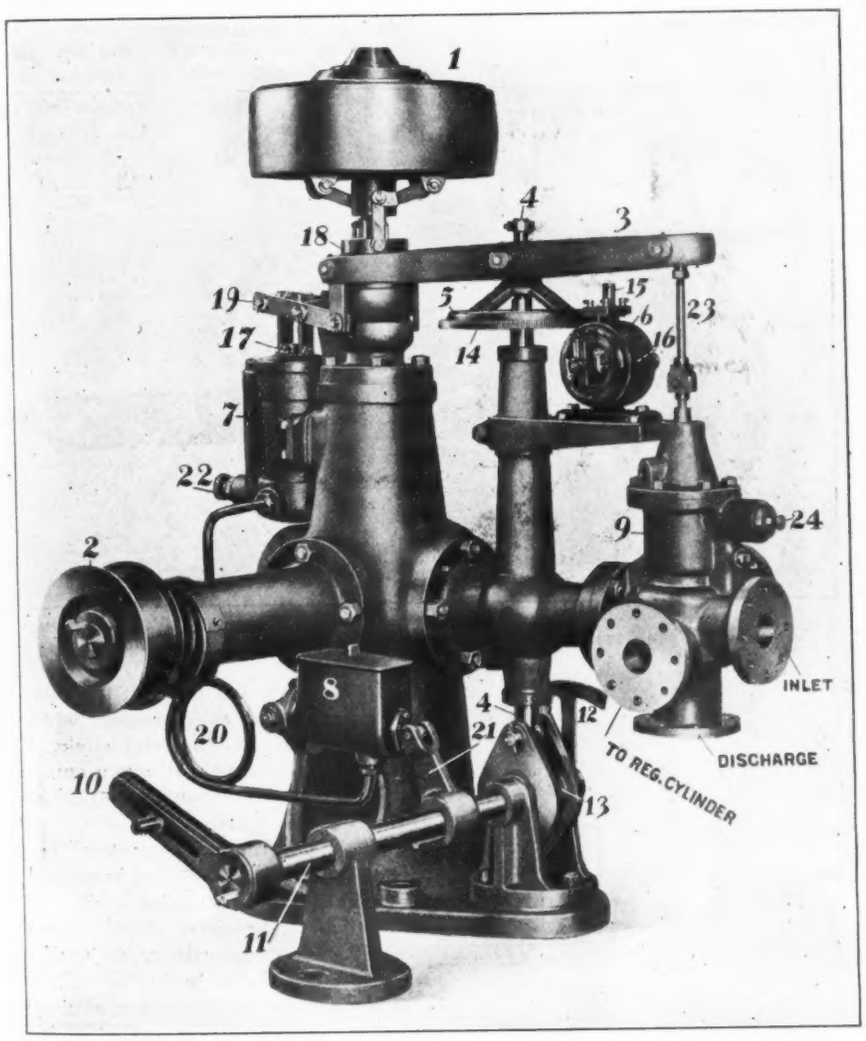


FIG. 1. THE GOVERNOR STAND AND ATTACHMENTS

The tendency toward increasing the size and power of units, and in utilizing higher heads, has, however, made the governor not only more difficult to design, but also a more important element in commercial operation, and greater precaution is now being taken by the builders of hydro-electric machinery to insure reliability under every possible condition of service. One result of this has been a tendency toward greater strength and simplicity of design.

It is now realized to a larger extent than ever before, that for mechanisms controlling power units of large capacity, simplicity, accessibility and a liberal factor of safety are the principal features to be considered. Particularly is this true of transmission systems distributing power for railway, lighting and industrial service over wide areas of country; for, with these, any derangement of the generating plant is liable to cause large loss and expense, if not serious disaster. Also to insure proper economy, from the standpoint of commercial regulation, a governor must control speed variation in as nearly an absolute minimum of time as possible, hold the speed substantially constant for uniform load, be "dead beat" in action and operate without hunting when running in parallel with other machines. It will be at once recognized that, in order to fulfil these conditions, maximum sensitiveness is a basic requirement of the design, but there have been in the past three considerations impelling a sacrifice of that feature, viz: The necessary provision of power for actuating the regulating valve when the delicate pilot valve was not resorted to; the danger of over-travel and consequent hunting action; the necessity, when long penstocks were used, of making the closing time greater than the "critical" time (that is to say, the time required for an oscillation set up by closing the wheel gates to travel twice the length of the penstocks), a result attained in a variety of ways, but usually at the expense of quickness or sensitiveness in governor design.

To follow out some of the points mentioned and see to what conclusions they

lead, let us take the new turbine governors recently brought out by a leading builder of hydro-electric machinery. These are the result of an evolution or development extending over many years, and they represent not only American experience, but also such features of Swiss and other European practice as are applicable to conditions existing in the United States, Mexico and Canada. The device described in this article is of the oil-pressure type and has three distinct elements: The governor stand, Fig. 1, containing the mechanism for controlling the time of application of energy for actuating the gates, the regulating cylinder for applying energy, and the pressure system for supplying the energy. Its operation may be briefly described as follows:

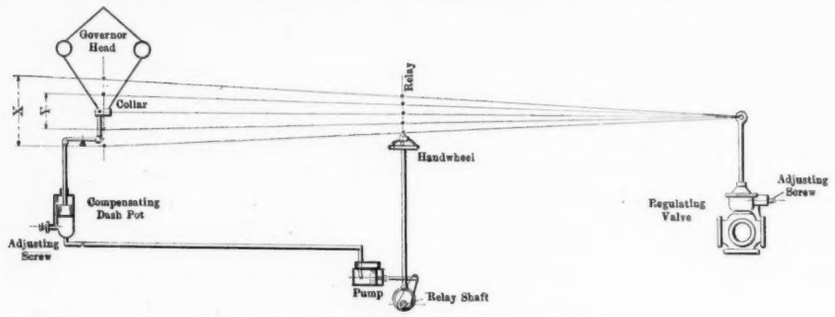


FIG. 2. OUTLINE DIAGRAM OF GOVERNOR

Operation of Governor

The governor head, designed to be a highly sensitive yet stable apparatus, and driven from the turbine shaft, forms, of course, the basic governing element. Any change in its position moves the governor collar, thereby shifting the floating lever, and through it and its connection with the relay (which momentarily acts as a stationary fulcrum) actuates the regulating valve. Any movement of this regulating valve admits oil from the pressure system to either the opening or closing side of the regulating cylinder and thereby actuates the turbine gates. The relay forms a mechanical connection between the regulating cylinder piston and the floating lever, constituting what may be termed a moving fulcrum, so that every movement of the regulating piston shifts the fulcrum point and brings the regulating valve back to mid-position, thereby making the mechanism "dead beat." If this movement is so adjusted that the position of these parts have the proper relation, the governor collar will practically retain a fixed position.

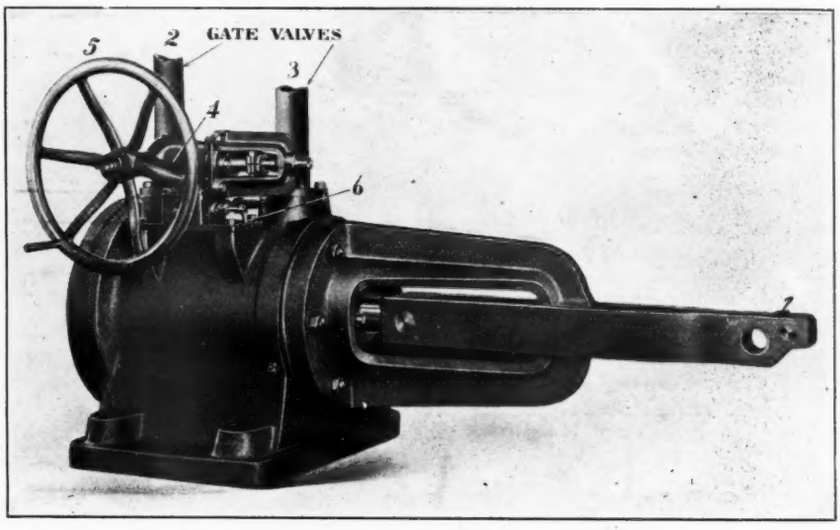


FIG. 3. ONE FORM OF REGULATING CYLINDER

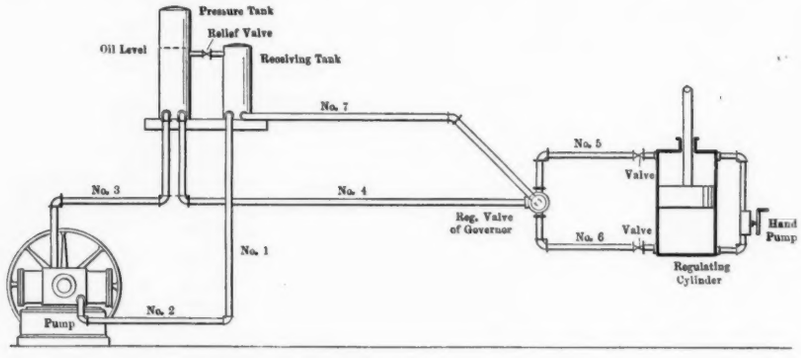


FIG. 4. PRESSURE-SYSTEM DIAGRAM

The regulating cylinder cannot, however, fully open or close the turbine gates instantaneously, and the above result can only be obtained within prescribed limits, a difference of speed occurring between no load and full load that requires a certain movement or travel of the governor collar. Consequently, the speed of the turbine at different gate openings will vary slightly and depend upon the speed of the governor at corresponding positions of the regulating piston stroke.

Under favorable conditions (open flume and short penstocks) the opening and closing times of the gates depend solely upon the inertia of the moving masses and aperiodic regulation can be obtained; that is, the stroke of the regulating piston and the travel of the governor collar correspond in time. Under unfavorable conditions (long penstocks) the closing time is often so influenced by the "critical time" already mentioned and by other considerations that aperiodic regulation is no longer practicable, since a travel of the governor collar would be required that would cause a greater difference in speed between no load and full load than is commercially allowable. To meet such conditions the compensating dash-pot is utilized.

In Fig. 2 the full travel of the governor collar is shown as corresponding to a speed change X. The relay stroke, however, is designed so that only a portion of this travel, corresponding to a speed change Y, is utilized; that is, within this limit the governor, without other mechanism than the relay, is "dead beat," and the regulating valve by relay action is returned to mid-position after each movement. The compensating dash-pot consists of a cylinder having an adjustable bypass and a compound piston with auxiliary spring device, the rod of which is connected through a suitable lever to the governor collar. Arranged so that its piston takes motion from the relay-actuating shaft is a positive displacement pump connected by a pipe to the compensating dash-pot cylinder. For slight changes of load a negligible displacement of oil takes place and the dash-pot has a slight damping action only on the governor head, but when any load change occurs of sufficient magnitude to produce a speed variation

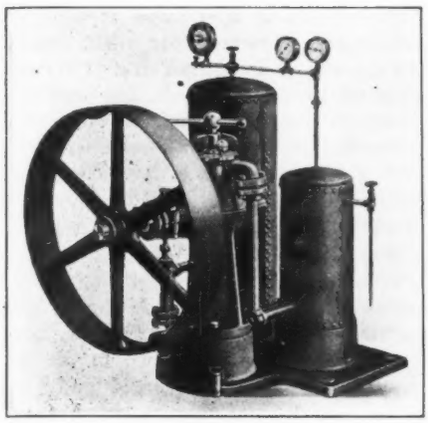


FIG. 5. SELF-CONTAINED PUMPING UNIT

greater than *Y*, as shown in the diagram, enough oil displacement takes place to bring the auxiliary spring effect of the dash-pot piston strongly into action until the fluctuation is controlled and the governor collar is again brought within the limits corresponding to *Y* speed variation, when action ceases. By this means a governing element of maximum sensitiveness can be used and the regulation of ordinary slight fluctuations made aperiodic, even under the most unfavorable conditions. These elements in design, therefore, result in the governors operating with great quickness and holding the speed variation due to ordinary fluctuations within the narrowest limits, yet being absolutely safe from hunting or overtravel after heavy load fluctuations.

Governor Parts in Detail

Governor stand—This is shown complete in the illustration, Fig. 1, and consists of a pedestal upon which are mounted the governor head *1* and drive *2*, floating lever *3*, relay *4*, hand control *5*, switchboard-control arrangements *6*, compensating dash-pot *7*, displacement pump *8* and regulating valve *9*.

Governor head—The "Hartung" type of head, with equilibrated levers, has been

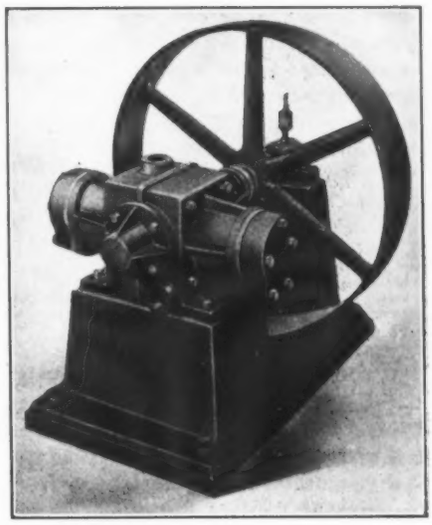
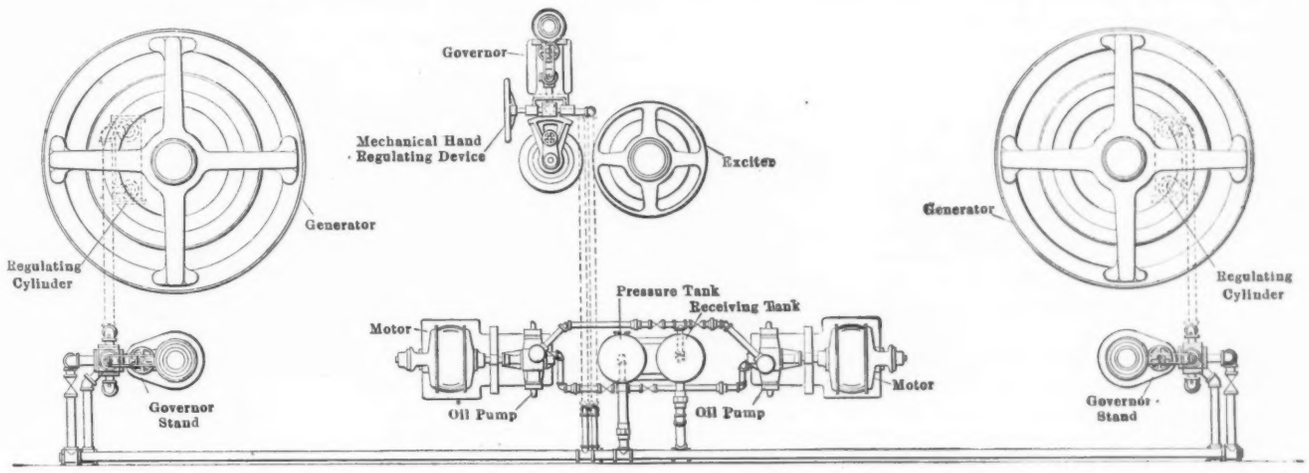


FIG. 6. DOUBLE-ACTING PUMP

adopted, on account of its great regulation capacity in proportion to its power. This is shown in the following table,



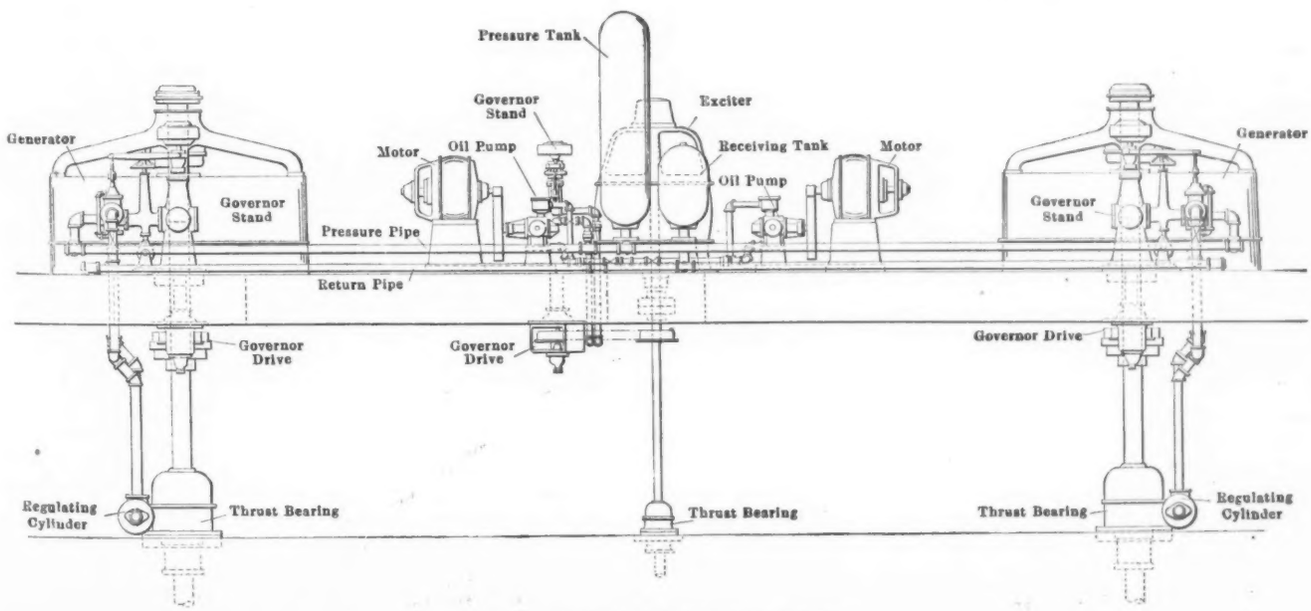


FIG. 8. CENTRAL OIL-PRESSURE SYSTEM

which gives comparative results obtained from a governor of this type and one of an ordinary design without equilibrated levers:

Design.	Force.	Energy.	Regulation Capacity.
Simple spring governor without equilibrated lever	1650 lb.	594 ft.-lb.	1650
"Hartung" type	528 lb.	144 ft.-lb.	2230

The "Force" of the first column is the force exerted by the governor collar, the "Energy" is this force in the maximum collar travel, and "Regulation Capacity" is the product of sensitiveness (expressed in terms of limit of fluctuations within which the governor is sensitive) by the uniformity of the regulation produced, expressed in terms of its coefficient of speed fluctuation. Each governor is tested and carefully adjusted for the required speed variation. The governor head is belt-driven from the turbine shaft, the motion being transmitted to the governor spindle through a pulley *2* and cut bevel gears running in oil.

Floating lever—The functions of this part have already been fully explained, and by referring to Figs. 1 and 2 its connection with the governor collar, compensating dash-pot, relay and regulating valve will be made plain. The lubrication for the collar is provided by an oil cup sufficiently elevated to supply the oil under a slight head.

Relay, hand and switchboard control—Through the adjustable relay lever *10* motion is transmitted from the gate gear to the relay shift *11*, at the end of which a gate-opening indicator *12* is provided, and thence by means of the eccentric *13* to the relay rod *4*, so that its point of connection with the floating lever becomes a moving fulcrum, and "dead beat" action is obtained. The hand-wheel *5* enables the effective length of the relay rod to be varied and the speed thereby regulated, thus providing a convenient method of hand control.

When required, the motor *6*, connected to the gear *14* on the hand-wheel by means of the disconnecting pinion *15* and worm wheel *16*, is supplied, and provides switchboard control for the governor, enabling the synchronizing of units and the adjustment of load by the switchboard operator through suitable switches mounted on the panels.

Compensating dash-pot and pump—The design and functions of this device *7* have been indicated. Its arrangement on the governor stand is clearly shown in Fig. 1. The compensating dash-pot piston rod *17* is connected to the floating lever *3* and governor collar *18* through the lever *19* and its connecting links. By a pipe *20* the dash-pot is connected to the pump *8*, the piston of which is actuated by a crank *21* on the relay shaft. The oil reservoir seals the pump cylinder and gland completely from air and thereby prevents loss of displacement. The dash-pot effect may be varied by the needle valve *22*, and it should be noted that this and all other adjustments that have to do with the governor's action can be made while the machine is in operation, an important feature from an operating and maintenance standpoint.

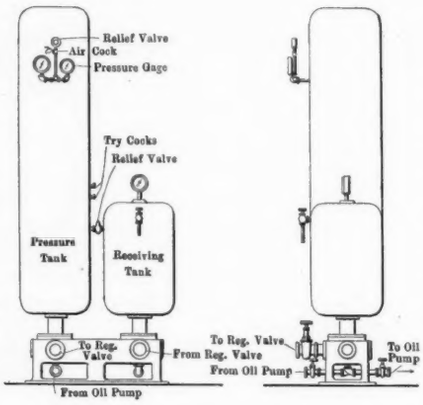
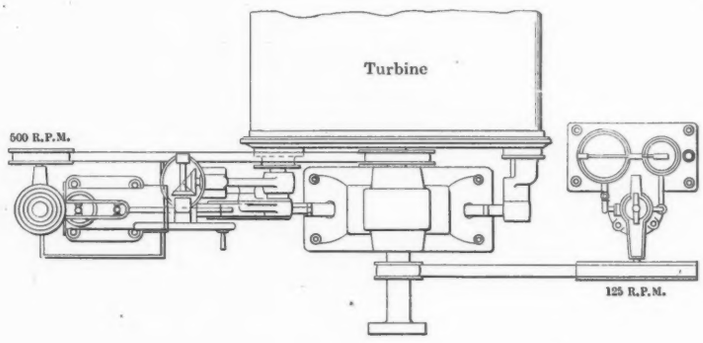


FIG. 7. TANKS FOR INDEPENDENT-UNIT SYSTEM

Regulating valve—The regulating valve *9* has no actual mechanical connection with the valve-stem *23*, but is actuated by unbalanced pressure, controlled through the opening and closing of a port by this stem. This valve is designed so that the force exerted by it is ample to shear off any small obstruction that might impede its movement, and it has proved entirely trustworthy in operation. The only adjustment required is that of the bypass controlled by the needle valve *24*; this, like other adjustments previously described, can be made with the governor in operation.

Regulating cylinder and connections—The regulating valve admits oil under pressure to the opening or closing side of the regulating cylinder, at the same time allowing that contained in the opposite end to be discharged into the vacuum tank, and thereby actuates the turbine gates. Fig. 3 shows one form of construction. The cylinder is mounted on a heavy seating arranged for fastening to a suitable foundation, and connection to the gate gear is made through the connecting rod *1*. The pipe connections shown provide for delivery and discharge of oil and are fitted with gate valves *2* and *3* in order that connection with the governor and pressure system may be closed and the turbine gates actuated by the oil pump *4*, driven by the hand-wheel *5*. A control valve *6* enables the pump to displace oil in either direction, so that the gates may be opened or closed by hand.



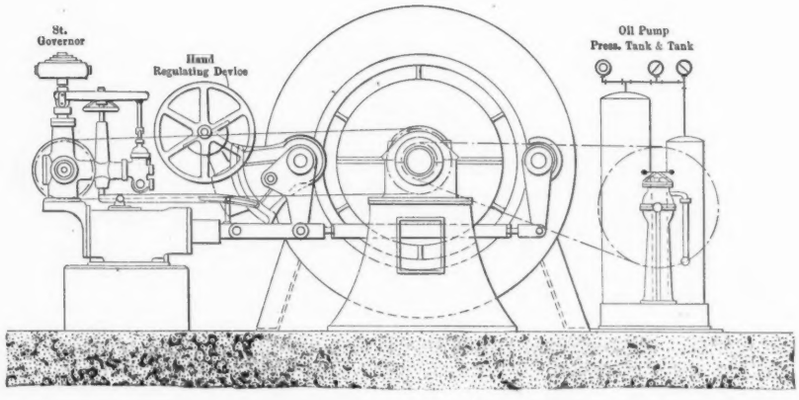


FIG. 9. ARRANGEMENT OF OIL-PRESSURE GOVERNOR, SIZE I

Oil-pressure system—The principle of oil pumping used for governor purposes will be made clear by referring to Fig. 4. The oil pump is continuously operated,

drawing oil from the vacuum tank and delivering it into the pressure tank. The pressure tank is half filled with a special quality of oil, the space above forming an air cushion and having an effect similar to that of an accumulator in overcoming the inertia of the oil in the tank and pipes, and enabling large quantities to be delivered promptly. Oil under pressure is led to the regulating valve; its admission to the regulating cylinder is thereby controlled and the discharge delivered to the vacuum tank. The oil is drawn from the vacuum tank by the pump and again delivered to the pressure tank.

Pumping Systems

Three arrangements of pumping apparatus are regularly made. These are adapted to the different sizes of governor and size and arrangement of units and are known as the "self-contained unit system," the "independent-unit system" and the "central-pumping system."

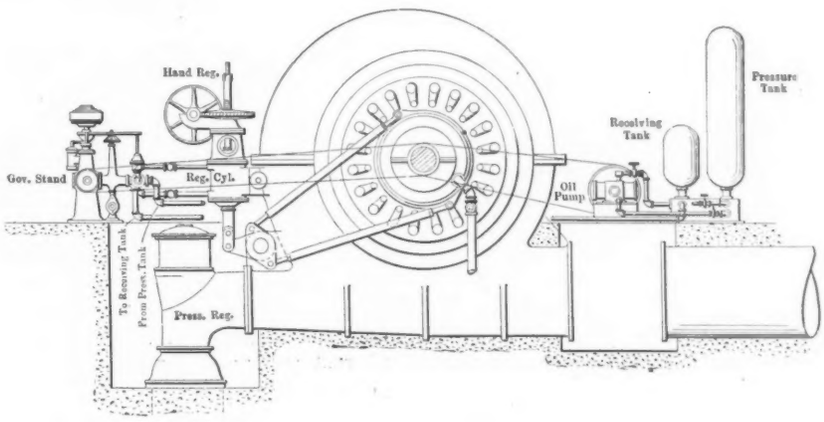


FIG. 10. ARRANGEMENT OF OIL-PRESSURE GOVERNOR SIZE 2

In the first-named system the arrangement, Fig. 5, consists of a single-plunger pump mounted on a common base with the vacuum and pressure tanks and belt-driven from the turbine shaft.

In the independent-unit system the type of double-acting pump, shown in Fig. 6, is used with governors of larger capacities. It is belt-driven from the turbine shaft, and only one is used for each turbine, making an entirely independent arrangement, although connections may be provided for temporarily using other units in case of accident. The pressure and vacuum tanks, shown in Fig. 7, are mounted on a common base and can be located in any convenient place, or a central-tank system common to all the units may be used. This arrangement provides a central pressure and vacuum tank with pressure and vacuum mains, to which the separate governors are connected, running the length of the power house.

In plants having many units, a gain in simplicity and convenience is obtained by the use of a duplicate central-pumping system, as illustrated in Fig. 8. For such arrangements the pumps may be driven by motors or by separate water wheels.

The development of the governing mechanism above described, for the several illustrations of which the writer is indebted to its builder, the Allis-Chalmers Company, has been the result of exhaustive experiments and extended experience in regulating units of different designs, including three 13,500-horse-power reaction turbines operating under 365 feet head and four 11,750-horse-power impulse turbines operating under 865 feet head, these being the largest units of their respective types so far constructed. The results obtained on tests under severe operating conditions are said to have demonstrated that this governor fulfils all the requirements necessary for good service. Two sizes are built, suited to varying requirements as to capacity and operating conditions.

Size 1, which is shown in Fig. 9, consists of the regulating cylinder and governor stand in one mechanism, auxiliary mechanical hand regulation being provided. This size has a maximum capacity of 10,000 foot-pounds and is applicable to turbines for operation in open flume, or where short penstocks are required. It is also well adapted to regulate exciter units and for impulse turbines of moderate capacities.

Size 2, shown in Fig. 10, consists of a separate regulating cylinder and governor stand, usually provided with hydraulic hand regulation. This size is made for any capacity and is applicable to all types of turbines, its special province being, however, in connection with long pipe lines and pressure regulators.

When either of these types of governor is used in connection with central oil-pressure systems having independent drives, all hand-regulating devices can be dispensed with, as the gates can be actuated from the relay hand-wheel at will, whenever oil pressure is available.

Smokeless Fuel

According to the *Mechanical Engineer* a London man has recently patented the following process for the manufacture of smokeless fuel: About one-third part by weight of wet peat and two-thirds part by weight of bituminous coal, which may be in a finely divided state, are taken and placed in a retort and heated to a temperature sufficiently high (about 850 degrees Fahrenheit) to drive off those hydrocarbons that produce smoke, the generation of the steam from the peat assisting in this operation. It will be understood that the temperature is not raised materially higher than is necessary to drive off the hydrocarbons as stated. The heat is applied for about five hours. The bituminous coal binds the peat together to a coherent mass and forms a fuel of high calorific value, which is readily ignited in a grate in the ordinary way and burns economically and without smoke.

In practice the retort may be provided with relief valves and arranged so as to maintain a pressure of 10 pounds per square inch. The retort may be heated in any convenient way, such as by heat externally applied or by burning some of the gases generated after partial purification.

The watery extract, containing tar of complex constitution, pyroligneous acid, and other products derived from the carbonization of peat, in addition to the gases referred to, is advantageously condensed and utilized for the production of a pitch of superior quality, and the usual condensable products obtained from the bituminous coal in the retort may be collected and used for any desired purpose. In some cases the contents of the retort after the process has been completed may, either while still hot or after they have cooled, be discharged into a solution of calcium chloride. By this means the smokeless fuel is rendered slightly deliquescent and always retains a certain quantity of moisture. The coal or the peat or both may also be moistened with a solution of calcium chloride before being placed in the retort.

Surface condensers require 1½ to 2 square feet of cooling surface per engine horse-power.

Safe fly-wheel diameter in feet equals 6000 ÷ (3.1416 × Revolutions per minute).

To find the weight of castings, multiply the cubic inches by 0.27 for iron, 0.29 for steel and 0.30 for brass.

Air-pump displacement should be 1/75 of the low-pressure piston displacement on a compound engine.

Test of a Small Gas Engine for Mixture and Ignition Timing

By T. C. Ulbricht

This article gives the salient results of a test made recently on a modern 7-horsepower horizontal gas engine of the four-stroke-cycle type, the aim being to determine the effects of various mixtures and spark adjustments on the output of the engine, rather than to ascertain its efficiency.

Every engine, of course, must be studied separately and adjustments made to give the best results with the fuel used, the speed of the engine, the work to be done, etc. Trouble may be found in the valves, timing mechanism, mixing chamber, reducing motion, indicators, etc., all of which parts should be thoroughly inspected and adjusted before a reliable test can be made.

In the present case, after the necessary preliminaries for starting the engine were completed, the igniter was set to spark just before the piston reached its inner dead center. The indicator was then attached and fine adjustments of the spark made until as perfect a card as possible was obtained, after which a series of indicator diagrams were taken, beginning with very early ignition and running past the known proper point to the other extreme of very late ignition. The first six diagrams reproduced herewith were taken with a proper mixture, to show the result of thus varying the timing of ignition. Fig. 1 shows too early ignition, with the spark set to occur about 25 degrees ahead of the dead-center position of the crank. Fig. 2 shows ignition about 20 degrees

FIG. 1

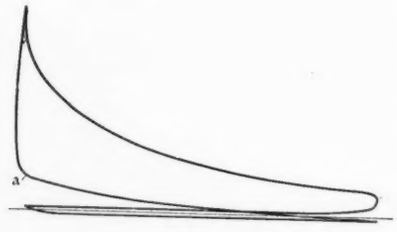


FIG. 2

ahead, resulting in an undefined explosion point at *a*; retarded piston speed; very high maximum pressure, due to the compression of the ignited gases, which could not expand until after the piston started on the out-stroke; and a combustion line sloping to the left of a vertical line drawn through the explosion point.

Diagram No. 3 shows a practically perfect card for this, as well as for any constant-volume engine. In this case ignition was timed at about 12 degrees advance, producing or permitting combustion a moment after the reversal of piston motion, giving a distinct explosion point *a*; an explosion line *a b* sloping slightly to the right of a vertical line through the point *a*; a smooth expansion line *b c*, dropping to a few pounds above atmospheric pressure; and a complete compression line *d a*.

In the cases illustrated by Figs. 4, 5 and 6, igniter operation occurred after the re-

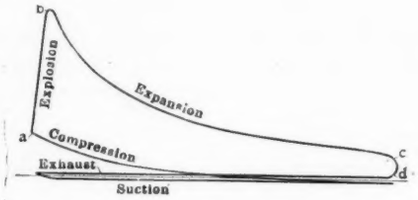


FIG. 3

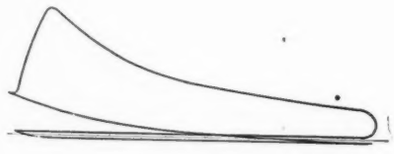


FIG. 4

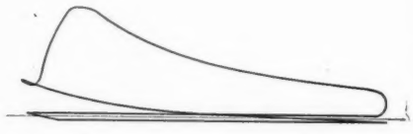


FIG. 5

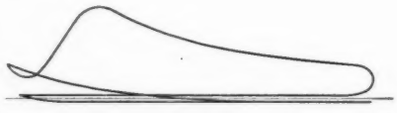


FIG. 6

versal of the piston motion by almost equal steps, resulting in a small point at the end of the compression line which gradually increases to a negative loop, due to the drop in pressure as the piston started on its return stroke. Explosion then occurred, giving a very slanting line, because the piston speed was being rapidly accelerated as the connecting-rod angularity increased with respect to the cylinder axis. The lag in the combustion line is more pronounced with later ignition, and there is obtained a lower maximum pressure, which is also of longer duration.

The ignition was next set at the proper point for the proper mixture and the mixture changed; first a very rich mixture being admitted, giving the diagram shown in Fig. 7. Here there is practically no explosion line, as no explosion occurred, but only a slow burning of the gases throughout the entire length of stroke, with the results that the maximum pressure is only slightly higher than the compression pressure, and the release pressure is but little below it.

FIG. 7. RICH MIXTURE

FIG. 8. LEAN MIXTURE

Then a very lean mixture was admitted, giving the kind of diagram shown by Fig. 8, which, although starting out with some rise in pressure due to initial combustion, shows slow combustion continued throughout the stroke, and indicates the possibility of some of the charge being still unburned when release occurred.

Peculiar Accident to Engine

By Ernest Hall

Recently the engine of the York (Me.) Light and Heat Company met with a peculiar accident. It is a 550-horsepower tandem compound engine, with 18x36-inch cylinders and 28-inch stroke, and was running condensing at 150 revolutions per minute. It was direct-connected to an alternating-current generator of 90 amperes capacity.

The accident resulted in the following damage: The steam pipe or, rather, the valve, was broken squarely off between the top flange and the hand wheel; the high-pressure cylinder was lifted off its bed and moved to one side about 4 inches out of line with the low-pressure cylinder, bending the 3⅛-inch rod with it. The high-pressure cylinder head went out, taking all its bolts (twelve ¾-inch) with it, the low-pressure cylinder head being split in five places, and all its bolts (twenty ¾-inch) being broken off, there being, besides, numerous other breaks. At the time there was 140 pounds steam pressure.

The piston rod had a slight bend in it and was sent away to be straightened. The repair people advised getting a new rod, saying that the old one was not safe. As a new one would cost some $250, they were told to go ahead and fix her up, which they did, with the above results. After the accident it was found that the piston rod, instead of entering the crosshead at its original size, was cut down or reduced from 4⅜ to 2⅞, for some reason, and then not being satisfied with reducing the strength, they butted it into the crosshead, forming a very rigid shoulder with no give to it.

Inquiries

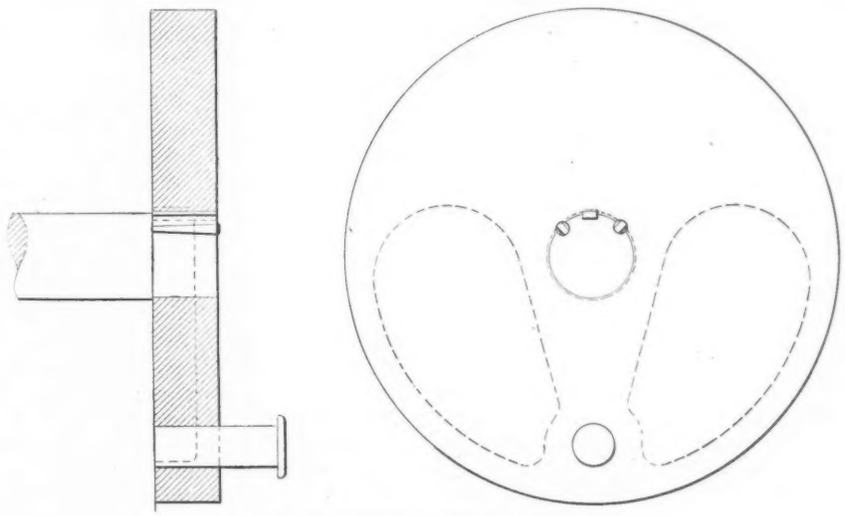
Questions are not answered unless they are of general interest and are accompanied by the name and address of the inquirer.

A Loose Crank

An 18x30-inch Corliss engine which runs at 123 revolutions per minute has a loose disk. Can a loose disk be made tight?

H. N. M.

Sometimes a disk or crank appears to be loose when it is not. Unless both shaft and the hole in the crank are perfectly round there is liable to be, between the shaft and the crank, space enough for oil to work through from the back side to the face of the crank, and make it appear that the crank is loose. It may in some cases be possible to secure the crank rigidly to the shaft by fitting a new key and driving it solidly home. A crank may be securely fastened by two taper pins, as shown in the drawing. Two holes are drilled perpendicular to the face of the crank, one-half in the shaft and one-half in the crank, about one-quarter of the shaft circumference apart. These holes are reamed with a taper reamer and pins are accurately fitted to the holes. Two sides of the pins are planed away so that they may have a bearing on opposite sides of the holes only. These pins should be driven simultaneously and finished flush with the face of the disk.



HOW TO FASTEN A LOOSE CRANK

Suction Limit of a Pump

Why is it impossible for a pump to lift water more than 34 feet?

J. C. T.

Because a column of water 34 feet high exerts a pressure equal to that of the atmosphere, and no matter how hard the pump may "suck," the atmospheric pressure cannot sustain a higher column of water. In practice, a pump will not raise water even as high as the theoretical limit of 34 feet, because of the "slippage" and the friction of the moving water against the pipe walls.

Location of a Gas-engine Ignition Plug

Why is the spark plug of a small gasolene engine, such as is used on automobiles, located usually near the inlet valve, and that of a large stationary gas engine located in the head or side away from the inlet? What is the best location for the igniter plug?

J. O. P.

The answer to your last question answers both. The best location for a spark plug is in a part of the cylinder where it will be most likely to be surrounded with a good "mixture" after the inlet valve closes. In an automobile engine, this position is usually near the inlet valve; in stationary engines it varies, according to the design of the cylinder and of the inlet passages, and the speed of the piston. The actual "best" position is debatable, but an infallible rule is to avoid pockets in the cylinder wall and proximity to the exhaust valve or ports.

Operating a Motor on Half Voltage

A 500-volt motor running on a 250-volt circuit will not run at high enough speed. Can it be changed so as to work properly at that voltage?

C. V. C.

It is doubtful. If the armature happened to be of the lap-wound variety and has a large number of coils, it can be changed to 250 volts by putting on a commutator having one-half the number of bars in the present commutator and connecting the coils in pairs. The field-magnet coils would have to be connected in two parallel groups instead of all in series. At best, such a change is a makeshift. Better have the armature and field magnet entirely rewound for 250 volts.

Pressures in the Cylinders of a Triple-expansion Engine

Knowing the steam pressure in the high-pressure cylinder of a triple-expansion engine, how can I calculate the pressures in the intermediate and low-pressure cylinders?

W. T. F.

Divide the initial pressure in the high-pressure cylinder by the ratio of expansion and the result will be practically the initial pressure in the intermediate; multiply this by the area of the high-pressure piston and divide by the area of the intermediate piston and the result will be the intermediate terminal and practically the low-pressure initial pressure. The low-pressure terminal pressure is equal to the initial multiplied by the intermediate piston area and divided by the low-pressure piston area.

Difficulty in Paralleling Direct-current Dynamos

Two 100-kilowatt direct-current dynamos of one make work in parallel without difficulty, but neither of them will go in parallel with a 200-kilowatt machine of another make; any attempt to parallel the larger machine with the others produces fireworks and the immediate opening of the circuit-breakers. All three are compound wound. What is probably the cause of the trouble?

J. E. F.

Either incorrect polarity or dissimilar equalizer connections. If the terminal polarities agree at the busbar connections, it is likely that the junction between the brushes and the series winding of the large machine is not of the same polarity as that of the smaller machines. For example, if the series windings of the smaller machines are connected to their negative brushes and the series winding of the larger machine is connected to its positive brushes, closing the main and equalizer switches will short-circuit all the armatures through the series windings.

Supplying Lamps with either Direct or Alternating Current

The lamps in a mercantile establishment are supplied normally with alternating current through the usual transformer and recording meter. It is desired to use a small direct-current dynamo on the premises for lighting during the small-load period; how should the entering connections be made?

H. W. O.

Put in a double-throw double-pole knife switch between the entering fuse-block and the meter. Connect it up so that closing it in one direction will connect the lighting main with the alternating-current meter and closing it in the opposite direction will connect with the feeder from the direct-current dynamo. This feeder must not at any time be connected to any part of the alternating-current supply circuit, directly or indirectly.

POWER AND THE ENGINEER

DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

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Boiler Room Economy

It is not clearly understood why in so many instances of power-plant installation so much stress is laid upon the steam-consumption and speed-regulation guarantees, and so little thought given to the boiler room and its equipment. Purchasers or their agents will haggle over a difference of five per cent. in steam consumption or a two per cent. variation in regulation, and serenely install and operate a steam-generating outfit that will allow a waste of from fifteen to twenty-five per cent. of the possible heat values of the fuel used. In the average modern boiler plant it is much easier to effect an appreciable reduction in the operating expenses by improvements in boilers, furnaces and chimneys than to improve upon the performance in the engine room.

One element of economy in the operation of the boiler room is the installation of boilers of proper capacity, with suitable grate areas and a chimney designed for the work to be done. If these items are neglected no ordinary effort will ever succeed in raising the efficiency of the plant above the average. Another factor is the fuel used, and the poor results achieved in many cases are due to the fact that neither the engineer nor his assistant knows one week, or in some instances one day, in advance the particular variety of dirt that will be furnished and called fuel.

It is not assumed that coal dealers are less honest than other business men, but the fact that they are in business primarily for profit, promises that the user will get whatever happens to be handiest for delivery, unless an intelligent oversight and subsequent loss of custom is expected by the dealer. Plant owners who buy coal without safeguard to insure good quality must expect to pay for their neglect. Coal in quantities should never be bought without some guarantee as to its value for steam-making purposes. Coal is burned for the purpose of transferring as large a percentage of its heat as possible to the water in the boiler, and a lack of engineering ability is shown in no clearer way than by a failure to accomplish this result. In a plant running twenty-four hours per day and seven days per week, the conditions would be much different from those in a plant operated only sixty hours per week, and the methods of coal handling and burning would be much different. In the one the installation of automatic stokers, conveyers and storage bins would be expected; while an outlay for similar apparatus in the smaller plant would entail interest and depreciation charges beyond all reason and out of all proportion to the good they might accomplish.

No leak of steam or water from joints or stuffing boxes, or of air into the furnace through the brickwork, is small enough to be unimportant. Common-sense methods are the ones needed and these only; in short, a liberal use of human brain in the boiler room will in a great majority of cases be productive of more direct saving to the plant owner than the adoption of all of the engine-room refinements devised in the last quarter of a century.

Air Leaks in Boiler Settings

Among the most common causes of lost economy in the steam plant are air leaks in the brick settings of the boilers. With few exceptions, steam-plant owners and chief engineers are contented with the conventional brick setting, with its many cracks and defects. The steam engine of today represents a machine as economical as modern skill and ingenuity can produce, while many improvements are also being made in the design of steam boilers; but the brick setting remains practically where it was in the beginning.

The reasons for cracked boiler settings are so well known that it is needless to mention them. As long as the common method of setting boilers is adhered to, with their weight resting on the brickwork, it follows that the strains of expansion and contraction of the boiler will be communicated to the setting; cracks will appear and more or less air will find its way into the furnace, to the detriment of economy.

As a means of eliminating such faults to a considerable extent, the method of suspending steam boilers from beam supports entirely separate from the brick settings should be employed, although this method has not been adopted to any great extent in the case of return-tubular boilers. Doubtless, this is due to the slight increase in the first cost of installation and the lack of knowledge regarding its merits. There are several evident advantages with this method of suspension, as the boiler is free to expand independently of the brickwork and the weight of the boiler and its contents is not supported by the setting. This method of setting boilers does not wholly prevent the formation of cracks, however, and additional means should be employed to overcome this difficulty.

As an example of the saving that may be made in fuel by merely preventing the radiation of heat through the brickwork and stopping air leaks in boiler settings, the following is worthy of note: A certain boiler setting was covered with a layer of asbestos cement, over which canvas was pasted, the whole being covered with thick coats of paint. The saving in this instance was more than twelve per cent. of the monthly coal bill. If such a saving can be made in one instance under ordinary operating conditions, it is evident that most engineers have an opportunity of making an appreciable saving in their fuel bills.

Another source of air leakage that does not seem to have been guarded against is found with most types of mechanical stoker, due to the dead area of the grate that is covered with a thin layer of clinker and ash. Undoubtedly this is obtained where medium and light fires are run, which would suggest that some method might be employed whereby the length of the grate could be shortened at will, so that the most efficient grate surface could be utilized under all loads on the boiler. This point should not be overlooked by designers of mechanical stokers. With one-third of the grate bare, as is frequently the case, the amount of cold air making up through the dead heating surface of the boiler makes it evident that a serious loss of heat units must take place. With some sort of arrangement to reduce the grate area, so that the grates would be always covered with live coals, this loss could be practically eliminated.

Flywheels for Water Power Turbines

Our attention was recently directed to the remarkable advantage obtained by the employment of large flywheels in equalizing the speed of shafting in several power plants operated by power from turbine water wheels. The main load in each of these places consists of silk looms, a class of manufacturing machinery very irregular in the use of power and at the same time very careful of material and damaging to product, unless operated with good uniformity of speed.

In each of the plants referred to steam engines had been installed as auxiliaries for furnishing power during the shortage of water. Whenever so employed, the superiority in uniformity of steam-engine speed was very noticeable, and return to the use of water power at the end of a "dry spell" would be postponed as long as possible.

In one plant, when occasion arose for hastily resuming the use of water power, the trouble and expense of cutting a large engine belt led up to the suggestion of leaving the belt in place, to disconnect the connecting and eccentric rods and let the flywheel and engine shaft run idle. This was done, and was accompanied by such decided improvement in the uniformity of the speed of the turbine water wheel that the change over to water was not observable, either to the operatives or in the working of their silk looms.

Several similarly equipped power plants in the same locality now employ their engine flywheels in this manner when running with water power, finding it results in very decided improvement in uniformity of speed, and especially in regulation of speed for sudden changes of load when the water-wheel governors are operating on "part gate."

There are few manufacturing enterprises where it is not vastly more profitable to use power with good uniformity of speed, to say nothing of those to which close regulation is an absolute necessity, and yet the man behind the check book, without relying on actual experience, would be more than likely to treat any engineer as a decided crank who would propose to improve the speed of a turbine water wheel by the installation of an eighteen-foot flywheel.

Reduce Losses in Handling Coal

In large coal-handling systems used in power plants of considerable capacity there is often a chance to save a few dollars in operation if the station staff is on the alert to cut down wastes. In a good sized plant there are frequently several hundred conveyer buckets to be driven, and a twenty- or twenty-five horsepower engine or motor may be needed to operate the system at its full capacity. With the most careful lubrication and skilled attention, the friction load of the conveyer system may amount to forty or fifty per cent. of the power required when operating with the buckets full. If care is not taken to shut down the conveyer promptly after the delivery of coal to the bunkers or when the collection of ashes has ceased, the power loss may be felt in the year's operating expense of the auxiliaries.

The operation of the endless conveyer chain, empty, once or twice a week for purposes of oiling or greasing may cost perhaps ten dollars a year for the extra power used, compared with lubricating when the conveyer is handling fuel. In large conveyer installations two men are often needed to apply the oil or grease as each bucket passes by, a third man being on hand to fill the cans. If this work can be arranged to be done when the conveyer is delivering coal, a desirable gain will be made, since there are always points in the travel of the conveyer belt or buckets where they are empty and thus readily inspected in detail or oiled in any part.

Two other frequent sources of waste in the handling of a coal-conveyer system are in the pocket lights and the steam lines which may be in use. Current is wasted through failure to cut off the incandescents as soon as they are not needed in the recesses of the pocket, and when several steam-pipe branch lines are used in connection with hoisting engines, if a main valve is not installed at the entrance of the pocket or tower, leakages in the separate valves are liable to prove expensive. Sometimes half the minor valves are in leaky condition, and the resulting excess coal consumption is worth saving. It is a good plan in electrically driven conveyer plants to check the mechanical condition of the buckets and chain by occasional ammeter readings. The actual saving from these different sources is, of course, small, but it must be remembered that this is only one of the many places in a power plant in which a saving might be effected.

Economy Tests of Gas Engines

The records of gas-engine economy tests usually show the results obtained with the mixture constant and the time of ignition varied, and those obtained with the timing constant and the mixture proportions varied, but it is seldom that anyone finds evidence of a thorough trial of the effects of varying both the mixture proportions and the timing of ignition. The shortest cut to the best adjustment of these two vital functions is to start with a fairly rich mixure, advancing the ignition as far as may be allowable; then reduce the proportion of gas to air little by little, each time advancing the ignition until the best possible results are obtained with that mixture. A point will soon be reached where any further improvement of the mixture will cause a decrease in power which cannot be cured by further advance of the ignition timing.

Tests with fixed ignition timing and variations of mixture quality are of little, if any, engineering value; they serve chiefly to satisfy one's curiosity as to just what sort of behavior such changes will produce. Of course, if one is unfortunate enough to have a gas engine (not oil engine) which has no provision for adjusting the timing of ignition, it must be tested with fixed ignition advance, if at all, but that type of engine is rapidly becoming obsolete and is scarcely worth the trouble and expense of running a complete test.

The great strides that have been made by the suction-gas producer in combination with the gas engine are evidenced by the report that the British naval authorities are going to give the combination a trial on shipboard, and great things are expected of it. This is heralded as a new discovery, but it has been in the minds of naval engineers for a long time. As long ago as the St. Louis exposition, Admiral Melville, in private conversation, expressed the belief that some day the gas producer might displace the boiler afloat as well as ashore. At that time this appeared like a remote possibility, yet now the beginning seems to be right at hand.—*Engineering and Mining Journal.*

To find the resistance of copper wire drop one cipher from the circular mils. The result is the number of feet per ohm.

Broken, loose fuel weighs per cubic foot: Anthracite, 54 pounds; bituminous, 49 pounds; coke, 27 pounds.

Power Plant Machinery and Appliances

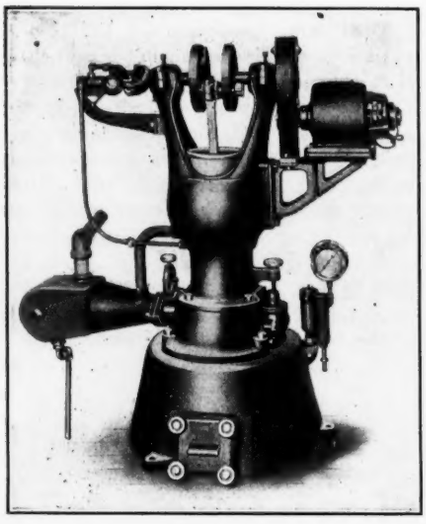
Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

A Vacuum Cleaning Pump

The vacuum-cleaning system herein described is manufactured by the Palm Engineering Company, Detroit, Mich.

The Palm vacuum pump is constructed with a piston fitting loosely in the cylinder, and between the piston and the cylinder a constant supply of water is maintained, which provides lubrication and reduces the piston friction to that within the water itself. This water keeps the cylinder washed clean, thus making it possible to take the dust-laden air directly into the pump and to discharge this dust with the water into the sewer. By this means the use of all wet or dry separators is eliminated and a corresponding saving of power is effected. The base of the pump is a vacuum equalizing chamber, and as the air flows into this some of the heavier particles of dust settle of their own weight. When it is necessary to clean this out, the base is easily and quickly opened by simply releasing a hand lever and swinging the cover to one side.

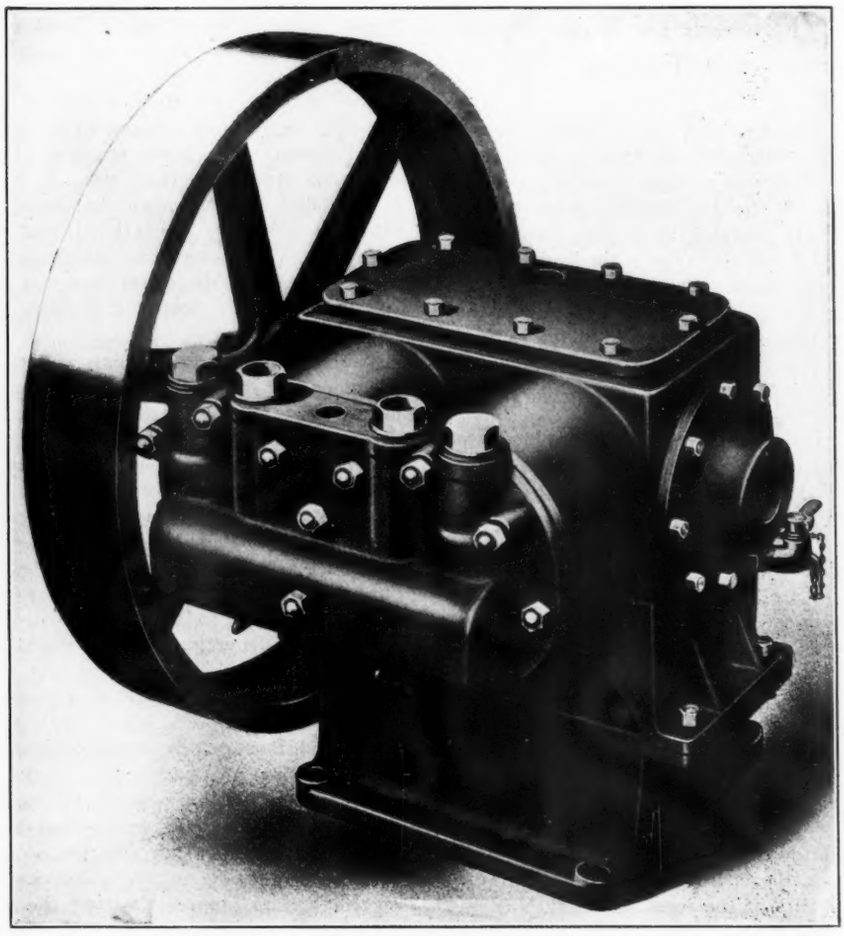


PALM VACUUM PUMP, TYPE "A"

This pump is operated by a ½-horsepower motor. It requires a space over all of two feet five inches by four feet and is four feet high, the base being twenty-four inches in diameter. It is entirely self-contained, even the motor being mounted on the frame. It requires no foundation other than a good floor, and as it is not taken apart for shipment it is quickly and easily installed.

New Type of Air Brake Air Compressor

The demand for the standard types of air compressor used with air-brake equipments to many industries requiring compressed air has broadened to such an extent that the Westinghouse Traction Brake Company, East Pittsburg, Penn., has found it necessary to provide a line of belt-driven compressors for cases where the only power available is from shafting or where it is not expedient to use either steam or electric motive power.



TYPE "F R" BELT-DRIVEN AIR COMPRESSOR

These belt-driven air compressors, designated as "Type F-R," are made in four different sizes, having 15, 26, 44½ and 54½ cubic feet of free air per minute capacity, respectively, at the standard speeds of 220 revolutions per minute for the first two types and 200 revolutions per minute for the last two. The horsepower required to operate the compressor in the four different sizes at 100 pounds pressure is 3, 5, 9 and 11, respectively.

They are said to operate successfully against pressures up to 200 pounds per square inch, and may be had with or without water-jacketed air cylinders as occasion requires.

This type of compressor is similar in all respects to the motor-driven compressor, except that the motor is replaced by a belt wheel, keyed on the crank shaft of the compressor. It is of the duplex, horizontal, single-acting type, and portable.

Corey Time Firing Device

The Corey time-firing device, used in the United States Navy, displays in succession the numbers 1, 2, 3, 4, etc., at such intervals as desired. It consists of a cylindrical case with a glazed opening near the bottom, back of which there is fixed a white, incandescent light. Between the light and the glazed opening there is a revolving aluminum dial actuated by an electromagnet with stenciled figures corresponding with the figures upon the furnace doors. A motor-driven transmitter is located in the engine room or at any convenient point and so wired to the indicators that the numbers will be indicated in all fire rooms at the same time. Upon the display of a number, the furnace doors bearing that number are opened and the fires therein coaled or given the necessary attention.

The Rothweiler Pipe Wrench

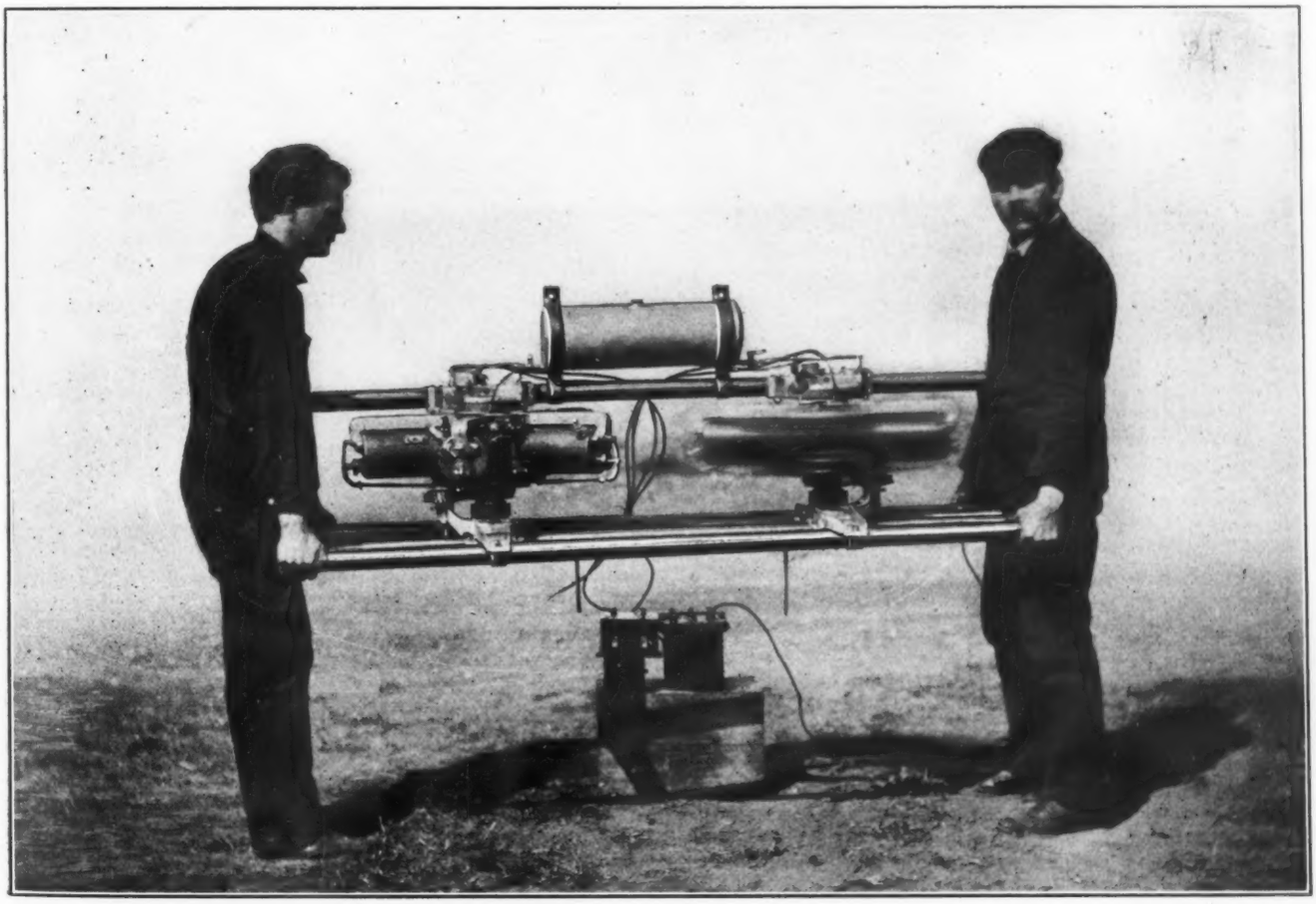
The pipe wrench shown in the illustration is made up of only six parts, which include the spring and pin inserted between the lower jaw and the gripping piece in such a manner as always to bring the sliding jaw back into position, after it has automatically moved down the incline to release the pipe. The wrench is made of drop-forged tool steel, thus giving a very powerful wrench of comparatively light weight. It is made by the Crescent Forgings Company, Oakmont, Penn.

A Lightweight Gasolene Motor

A gasolene motor of exceedingly light weight per horse-power developed has been brought out by the Adams Company, of Dubuque, Iowa. The motor is the design of F. O. Farwell, patentee of the revolving cylinder motor used in the Adams-Farwell motor car, and while it is built on the same general lines as the automobile motor, by refinement it becomes an interesting example of light weight and possesses many interesting peculiarities. It has five cylinders, of 4¼-inch bore and 3½-inch stroke, and is run at a speed up to 1800 revolutions per minute.

A DROP-FORGED PIPE WRENCH

The motor complete, in operative condition, with timer, float-feed carbureter, automatic force-feed oil pump and oil tank, weighs 97¼ pounds. With the spider, which secures the motor to four tubes, as shown in the accompanying view, the motor, base and all weighs 104 pounds. By the A. L. A. M. rule this motor is rated 36 horse-power. The photograph shows two of these 36-horse-power motors held in the hands of two men, while one of the motors is running at full speed. The absence of vibration is shown by the clearness of the photograph of the parts not in motion.



ONE ENGINE UNIT RUNNING TO SHOW THE ABSENCE OF VIBRATION BY THE CLEARNESS OF THE STATIONARY PARTS

Its weight per horse-power developed is believed to be the lightest of any motor not sacrificing strength and durability to weight. In comparing weights it is well to take into consideration the fact that the weight of the water, radiator, piping and fan used in water-cooled motors are

not often given with the weight of the motor. The light weight of this motor, which is air-cooled, is brought about more by the simplicity of its construction and the high grade of the material used than by the reduction of strength to the minimum, and it is supposed to stand as hard and continuous use as the regular automobile motors, some of which have been in use for eight years and are in fine running condition today.

Siphonic Action Caused Trouble

By W. E. Joyce

A peculiar instance of trouble developed at the plant of a municipal water company, where the work of rebuilding the pipe line was placed in the hands of what was doubtless a competent workman, but who had never acquired the theoretical knowledge which a course in hydraulics provides. The company in question decided to build a new line and to take a shorter route, placing at the point of work sufficient power to overcome the resistance which a series of elevations and depressions across mountains and valleys caused.

They had employed a pipe-line man who had been regarded as very competent and who had every confidence in his ability to undertake such a proposition. The services of an engineer were not deemed necessary and so the line was constructed. It was, on the whole, a very neat job, and as far as the mechanical end of it went there could not be any fault found. The topography of the country brought the line up over a short mountain or hill immediately above the power station. Descending into the valley the line again mounted another hill, the elevation of which was considerably higher than the first, and the fall on the other side was correspondingly longer.

The pumps were started and the water was forced across to the town for service. It was then noticed that on the second incline there was a serious thumping disturbance shown within the pipes, and so violent did it become that it was found impossible to keep the joints firm. It was suggested that the pipe used was too light and accordingly heaver pipe was purchased, but the thumping continued. Another line of pipe was laid the entire distance in the hope of overcoming the trouble, but nothing they did stopped the hammering.

About two years elapsed, during which time repairs were constantly being made and the patrons were threatening more serious trouble. It then happened that a man versed in hydraulics made a tour of the line. He soon discovered that at the second elevation siphonic action was taking place and it was impossible to keep the pipes filled with water. The vacuum thus formed left a space which each stroke of the pump had to break through. A small air vent was drilled in the pipe where it started on the second decline and immediately the thumping stopped. The value of such knowledge is obvious.

Personal

Prof. M. C. Beebe has been appointed professor of electrical engineering, in charge of the department, of the University of Wisconsin.

W. O. Vilter, of the Vilter Manufacturing Company, of Milwaukee, has been in Europe since the first of April and will return the first of October. The trip, which is a vacation one, has taken him practically all over continental Europe.

Business Items

The Clarkfield Roller Mills and Electric Light Company, of Clarkfield, Minn., has placed an order with the Minneapolis Steel and Machinery Company for an 80-H.P. Muenzel producer gas engine and suction-gas producer for running their mill and electric-light plant.

We have received from the Chas. A. Schieren Company, New York City, a wall ornament, which also possesses utility, consisting of an illustrated card upon which are mounted a thermometer and a barometer, together with an advertisement of "Duxbak" belting.

The Power Equipment Company, with offices at 50 Church street, New York City, with a capital stock of $50,000, has been formed for the purpose of handling the Eastern sales of the Skinner Engine Company's engines, of Erie, Penn., and the Union Iron Works' boilers of the same city.

The Parker Boiler Company, of Philadelphia, Penn., is erecting two 202-horsepower boilers for C. Deutermann & Son, White Plains, N. Y.; two 136-horsepower at the State Normal School, Marquette, Mich., and one 258-horsepower for the home of the Sisters of Good Shepherd, Wheeling, W. Va.

The Defiance Machine Works, Defiance, Ohio, are using Buckeye boiler skimmers in two of the boilers in their plant and say that they keep their boilers clean, effecting a saving in boiler compound alone during the year to more than pay for the skimmers. These skimmers are made by the Buckeye Boiler Skimmer Company, South End, Toledo, Ohio.

To those who use or contemplate the installation of machinery for handling water in large quantities for such purposes as circulating water for condensers and for irrigation or draining, emptying mines, etc., the perusal of the catalog of the Dayton Hydraulic Machinery Company will prove interesting and instructive. Aside from illustrations of different types of pumping machinery built by this company, the book contains a great deal of useful hydraulic engineering information.

The Schaeffer & Budenberg Company has sold its plant at Foxboro, Mass., to the Industrial Instrument Company, which was lately organized with Bennett B. Bristol, formerly of the Bristol Company, Waterbury, as its head. The Standard Gauge Manufacturing Company will operate the plant for the manufacture of gauges, recording instruments, etc., and the property will be deeded to this company by the Industrial Instrument Company, as the same interests control both concerns. Watson E. Goodyear, of Naugatuck, Conn., will be president of the Standard Gauge Manufacturing Company, Bennett B. Bristol, treasurer and Arthur F. Mundy, of Syracuse, N. Y., secretary. The plant is modern and well equipped, with two main buildings of brick, 60x210 feet each, and a foundry 60x150 feet, which was added a few years ago at a cost of $20,000. No extensive orders for equipment will be placed at once, but different machine tools will be ordered as required.

New Equipment

R. E. Medford & Co., Bonham, Texas, will erect and equip an ice plant to cost $150,000.

The Godel Packing Company, Peoria, Ill., will rebuild its plant recently destroyed by fire.

The Cameron (Texas) Water, Power and Light Company is erecting a cold-storage plant.

The city of Bucyrus, Ohio, has decided to erect a municipal electric plant to cost $90,000.

The town council, Tybee, Ga., is considering the question of installing a municipal electric-light plant.

The citizens of St. Marys, Kan., voted to issue $15,000 bonds for construction of electric-light plant.

The Terry Steam Turbine Company, Hartford, Conn., will erect a new factory building and power plant.

The town of Cashmere, Wis., proposes to erect a municipal electric-light plant and water-works system.

The Auburn (N. Y.) Light, Heat and Power Company will double the capacity of its plant on North street.

Bids will be received until Sept. 22 by the board of trustees, Shortsville, N. Y., for the construction of water works.

The Delaware & Hudson Company will install an electric generating plant to serve its office building, in Albany, N. Y.

John P. Connor, Sante Fe, N. M., is promoter of an enterprize to build a $20,000 power plant on the Pecos river.

Plans are being prepared for Farrington & Bowman, Marcellus, N. Y., for water works for that place to cost about $20,000.

Bids will be opened about Sept. 22 for the construction of water works at Keewatin, Minn. P. A. McEachin, village recorder.

A fourth plant of 8000 horsepower is to be erected by the Nevada-California Power Company, of Tonopah, Nev., at Bishop Creek, Cal.

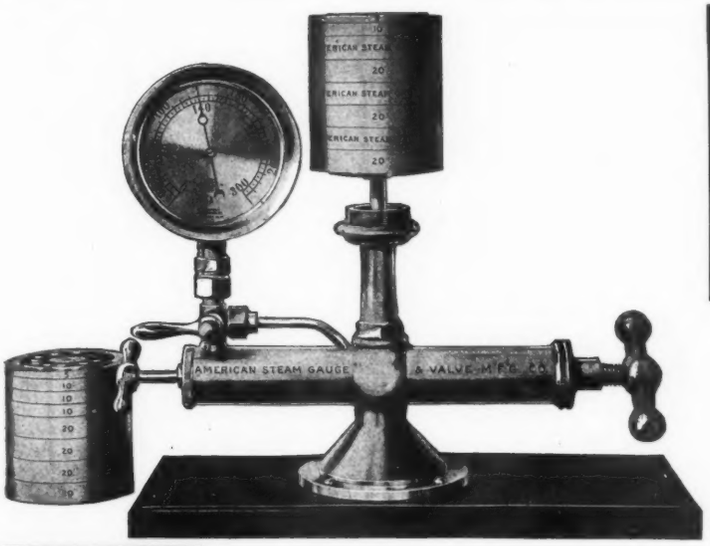
The Fremont (Ohio) Power and Light Company, recently granted a franchise, will erect a power plant at Bayville, near Fremont.

Van Houten Bros., Fishkill Landing, N. Y., will build an electric-power plant for supplying manufacturing establishments with electric power.

The Board of Water Commissioners, Temple, Texas, is reported to have decided to spend about $35,000 for improvements to water works.

Bids will be received by the Board of Public Service, Minerva, Ohio, until Sept. 24 for 150-horsepower boiler for municipal lighting plant. L. F. Weber, secretary.

The Morgantown (Ind.) Light and Power Company has been incorporated to construct and equip a lighting plant. Directors, W. T. Gibson, Jas. A. Collett, and others.



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The American Dead Weight Gauge Tester

—an instrument which enables you to show up the slightest discrepancy in steam gauge action.

If you require 150 pounds pressure and your gauge indicates that amount, when in reality you are carrying 180 pounds, you should know it in order to stop the waste.

THE AMERICAN DEAD WEIGHT GAUGE TESTER is the simplest and most accurate gauge tester in existence. It possesses all the advantages of a Mercury Column enclosed in much smaller space.

Write for descriptive circular of this instrument.

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When ordering gauges, valves, indicators and kindred appliances for governing, indicating, measuring, recording and controlling steam, air, gas, oil, ammonia and all other pressures, be sure to specify those manufactured by us. Your interests can be best served by the protection they afford.

New Catalogs

Niles-Bement-Pond Company, 111 Broadway, New York. Catalog. Boring mills. Illustrated, 46 pages, 9x12 inches.

Dean Bros. Steam Pump Works, Indianapolis, Ind. Catalog No. 71. Power pumps. Illustrated, 40 pages, 6x7 inches.

Revere Rubber Company, 77 Bedford street, Boston, Mass. Catalog. Packings. Illustrated, 60 pages, 5½x7½ inches.

The Dayton Hydraulic Machinery Company, Dayton, Ohio. Bulletin No. 81. Turbine pumps Illustrated, 28 pages, 6x9 inches.

B. F. Sturtevant Company, Hyde Park, Mass. Bulletin No. 159. Electric motors, type H. Illustrated, 8 pages, 6½x9 inches.

Hercules Float Works, Springfield, Mass. Catalog. Seamless copper floats and air chambers. Illustrated, 8 pages, 3½x6 inches.

The Arctic Ice Machine Company, Canton, Ohio. Catalog. Ammonia fittings and supplies. Illustrated, 152 pages, 6x9 inches.

The Toledo Pipe Threading Machine Company, Toledo, Ohio. Catalog. Pipe threading devices. Illustrated, 24 pages, 5½x7 inches.

American Steam Gauge and Valve Manufacturing Company, Boston, Mass. Pamphlet. Indicators. Illustrated, 70 pages, 6x9 inches.

The Blake Pump and Condenser Company, Fitchburg, Mass. Catalog. Steam pumps and condensers. Illustrated, 48 pages, 5½x8 inches.

National File and Tool Company, 205 The Bourse, Philadelphia, Pa. Catalog. Vixen patent milling file. Illustrated, 16 pages, 4½x7½ inches.

Golden-Anderson Valve Specialty Company, Pittsburg, Penn. Catalog No. 11. Steam and water specialties. Illustrated, 64 pages, 5½x8½ inches.

The D. T. Williams Valve Company, 904-910 Broadway, Cincinnati, Ohio. Pamphlet. Oil and grease cups. Illustrated, 24 pages, 3½x6 inches.

Green Engineering Company, Commercial National Bank building, Chicago, Ill. Catalog. F. Green traveling link grates. Illustrated, 36 pages, 7x10 inches.

The Sarco Fuel Saving and Engineering Company, West street building, New York. Circular. Table showing saving in fuel resulting from use of Sarco CO_2 recorder.

Allis-Chalmers Company, Milwaukee, Wis. Bulletin No. 1611. Description of sewage pumping station, Chicago, equipped with Allis-Chalmers pumping machinery. Illustrated.

Liberty Manufacturing Company, 6910 Susquehanna street, Pittsburg, Penn. Bulletin No. 50. Liberty-Greenaway separators for steam, oil, ammonia and air. Illustrated, 10 pages, 6x9 inches.

The Bristol Company, Waterbury, Conn. Bulletin No. 91. Recording thermometers, Class I, temperatures to 250 degrees Fahrenheit. Illustrated, 12 pages, 8x10½ inches. Bulletin No. 93, recording thermometers, Class III, temperatures, 40 to 800 degrees Fahrenheit. Illustrated, 12 pages, 8x10½ inches.

Help Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

STEAM ENGINE ERECTING ENGINEER, capable of assisting in sales department, young man with shop experience and wide acquaintance among Eastern engineers preferred. Box 33, POWER.

NOTICE TO ENGINEERS—If you are desirous of making a change we offer the best opportunity for a nice income to the right man. The best selling specialty for a boiler extant. Selling for $50.00 each. A necessity for every boiler. Liberal contract. Address Power Specialty Co., 236-A. Fort St. W., Detroit, Mich.

Situations Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

CHIEF ENGINEER of large industrial plant desires change; active and alive, an expert with indicators and testing apparatus, can keep operating expenses at proper figures. Box 27, POWER.

ENGINEER, three years in present position, having charge of 2000 H.P. plant, desires a change. Capable of taking charge of a plant of this or larger size. Good reference. "L. M.," POWER.

POSITION WANTED as engineer. Seven years' experience with various makes of engines. Can furnish best references. Emanuel Dubrusky, Ithaca, Neb.

Miscellaneous

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ALL PRACTICAL ENGINEERS should apply to Wm. O. Webber, Consulting Engineer, 432 Exchange Bldg., Boston, for information concerning tables on all engineering subjects

PATENTS secured promptly in the United States and foreign countries. Pamphlet of instructions sent free upon request. C. L. Parker, Ex-examiner U. S. Patent Office, 4 Dietz Bldg., Washington, D. C.

WANTED—Patented articles which can be used in machine shop, boiler room or engine room. Must have merit. We possess finest facilities for marketing, having a large force of traveling men in this country, and agents in nearly every large city of Europe, who call upon steam users and machine shops. Liberal contract. Highest of references. Address Power Specialty Co., 236-A. Fort St. W., Detroit, Mich.

CO_2 RECORDER wanted. Box 39, POWER.

For Sale

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—Two 60"x16' H. T. boilers; two 52"x16' H. T. boilers; one 8"x10", 125 R. P. M., Imperial engine, direct connected to 25 kw., 125 V., direct current Triumph generator; one 7"x8", 375 R. P. M., direct connected to 10 kw., 125 V., direct current generator; one 20 H.P. 500 V. Edison motor; one 7½ H.P., one 3 H.P., and one ½ H. P., 500 V. direct current General Electric motor. Address Thompson Hotel Company, Lincoln, Neb.

150 HORSE-POWER tandem compound Corliss engine, in good order; 16-ft. wheel; 24-in. face. F. W. Iredell, 11 Broadway, New York.

FOR SALE—12x15 Erie City Iron Works engine at a bargain. Address Box 34, Coulterville, Ill.

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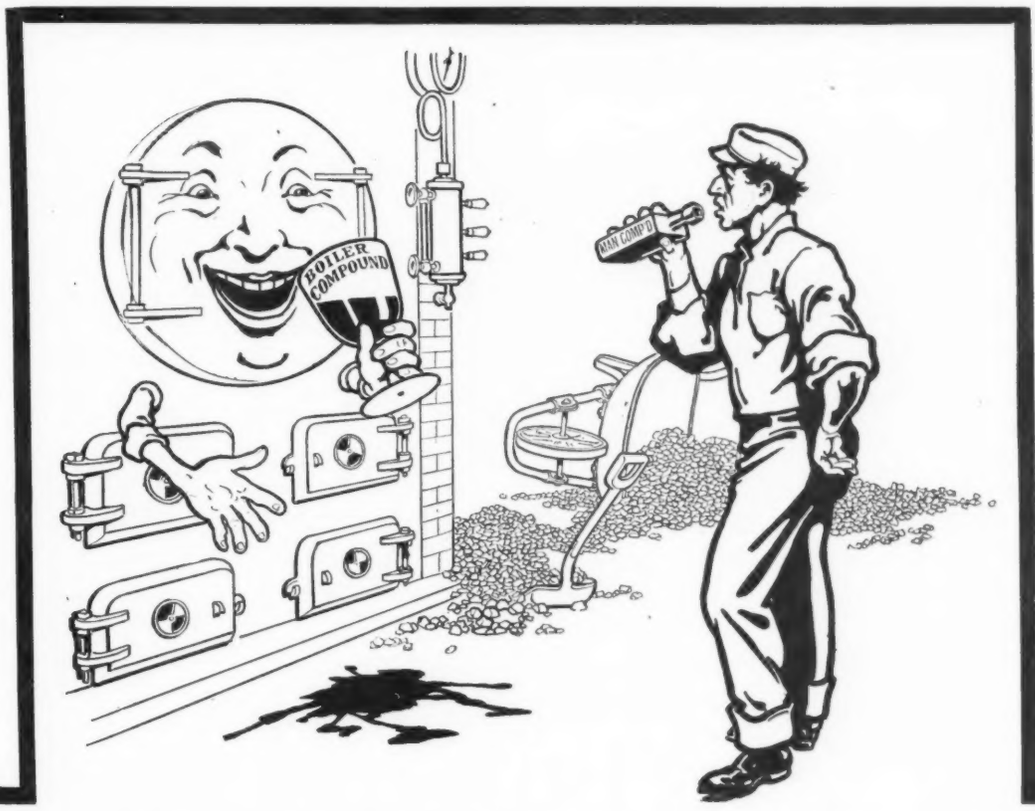

"HERE'S TO OUR FRIENDS, THE ENEMY, SCALE SEDIMENT, CORROSION, DEFECTIVE TUBES, BURNT AND BLISTERED PLATES AND LEAKY SEAMS," said the boiler as it gulped down a few galions of boiler compound.

"AND HERE'S TO THE CONFUSION OF THE WHOLE ESTABLISHMENT" said the discouraged fireman as he took a pull from a bottle.

RATHER BAD STATE OF AFFAIRS IN THAT PLANT! Cure about as dangerous as the disease. Better try prevention and make conditions easier for the boiler and more pleasant for the fireman by installing our **HOT PROCESS SYSTEM OF WATER PURIFICATION.**

Where water is purified by our Hot Process hard scale will not form in the boilers and they can be washed out easily with water from a hose. Injured plates and tubes become a thing of the past. Fifteen per cent. or so less fuel is required and as our System conserves all available exhaust steam, the water bill is likewise reduced. Further, our apparatus performs purification at the least possible cost, as heat performs the work of one of the chemicals required by other systems, and the single chemical employed is the cheapest effective softening reagent on the market.

There are no complicated and troublesome analyses to make. The apparatus does the work or takes the place of feed-water heater, return and expansion tanks, hot well, cold water regulator, independent oil separator, trap and receiver pumps. It is the only logical method for converting cold hard water into hot, soft water suitable for boiler feeding.

We shall be glad to have you write us about the conditions in your plant.

HARRISON SAFETY BOILER WORKS,

17th and Clearfield Sts., PHILADELPHIA, PA.

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System, Chicago, Ill.

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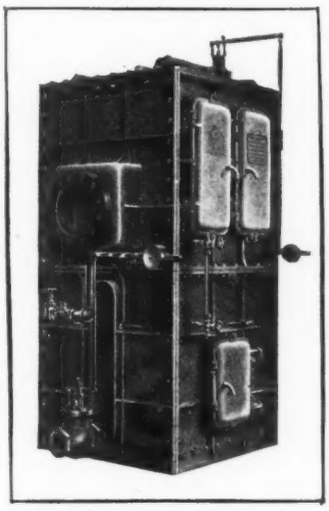

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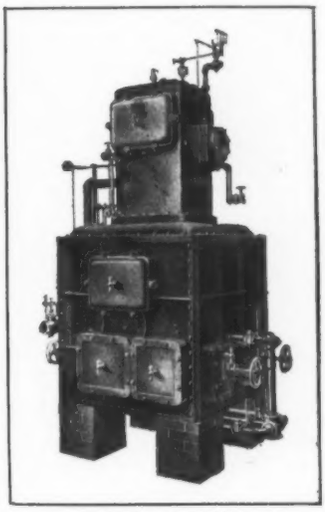

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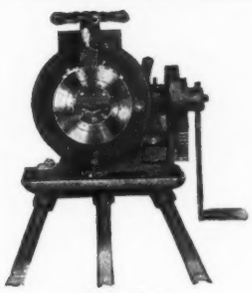

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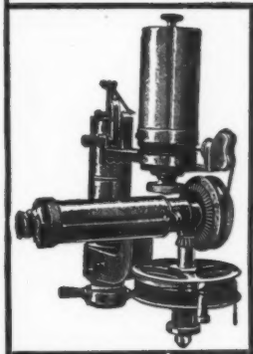

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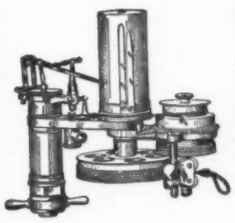

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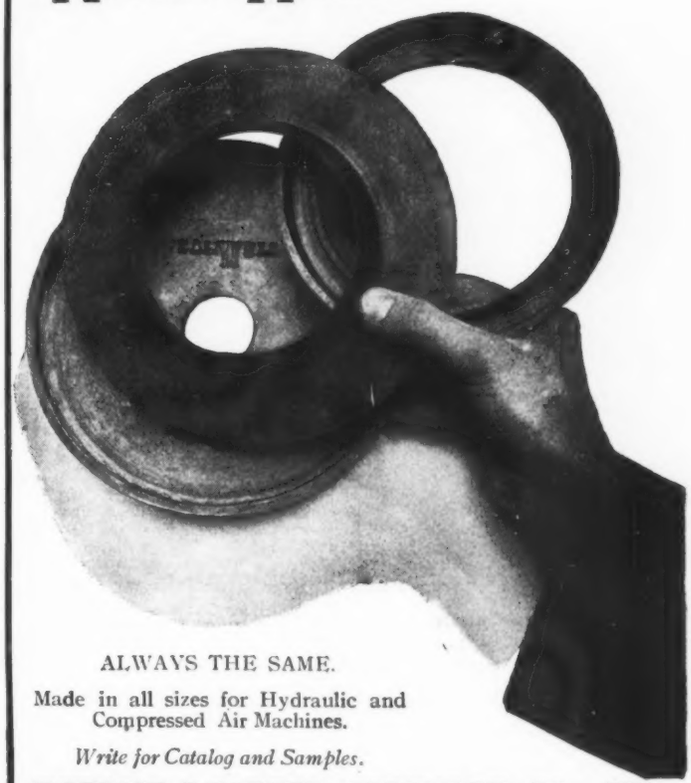

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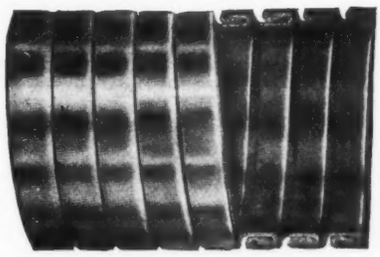

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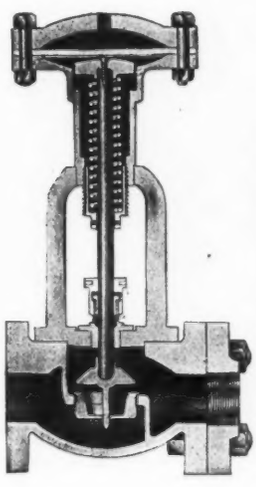

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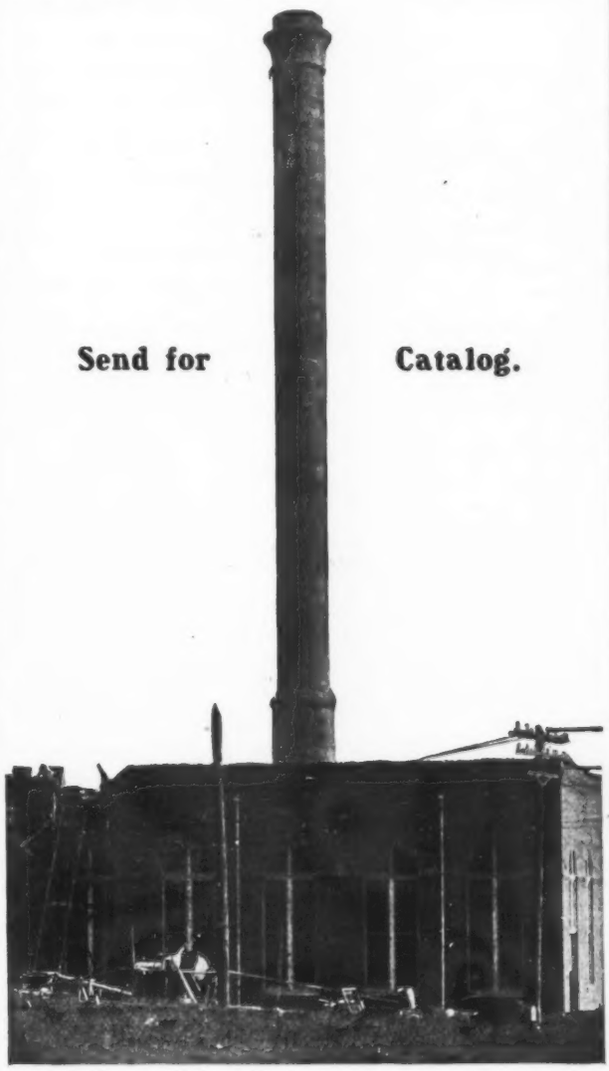

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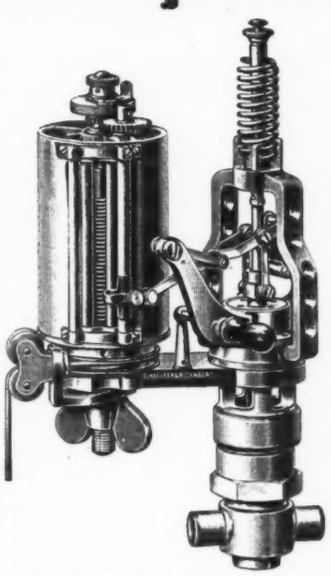

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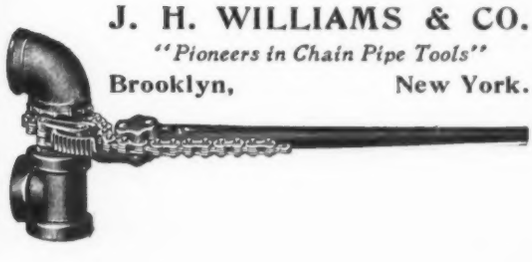

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Lagonda Manufacturing Co., Springfield, O.
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Valves, Automatic Relief
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Valves, Back Pressure
Best Mfg. Co., Pittsburg, Pa.
Davis Regulator Co., G. M., Chicago, Ill.
Jenkins Bros., New York.
Pittsburgh Valve, Foundry and Construction Co., Barberton, O.
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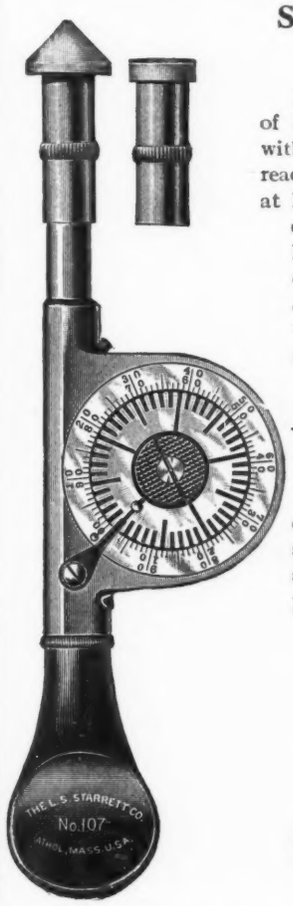

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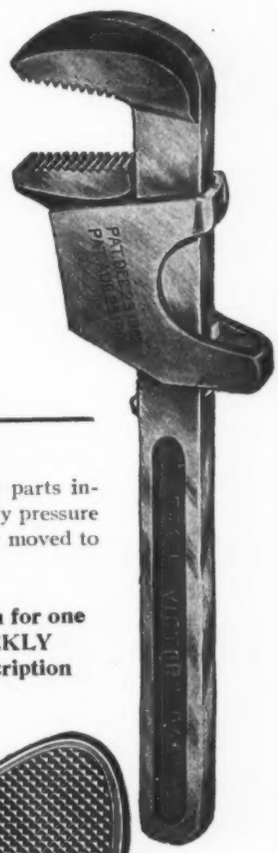

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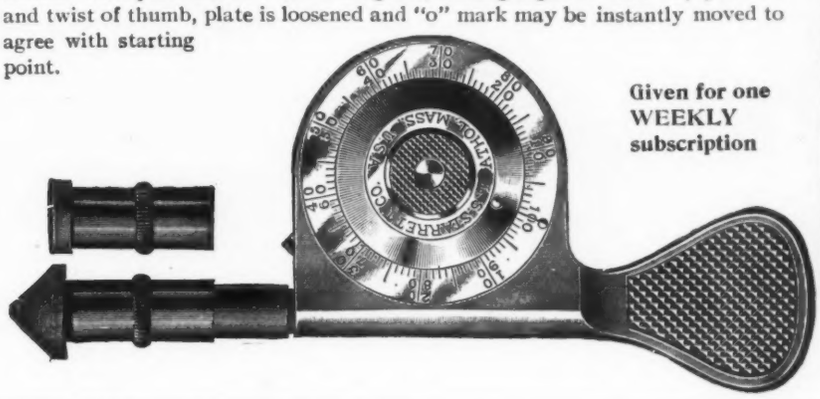

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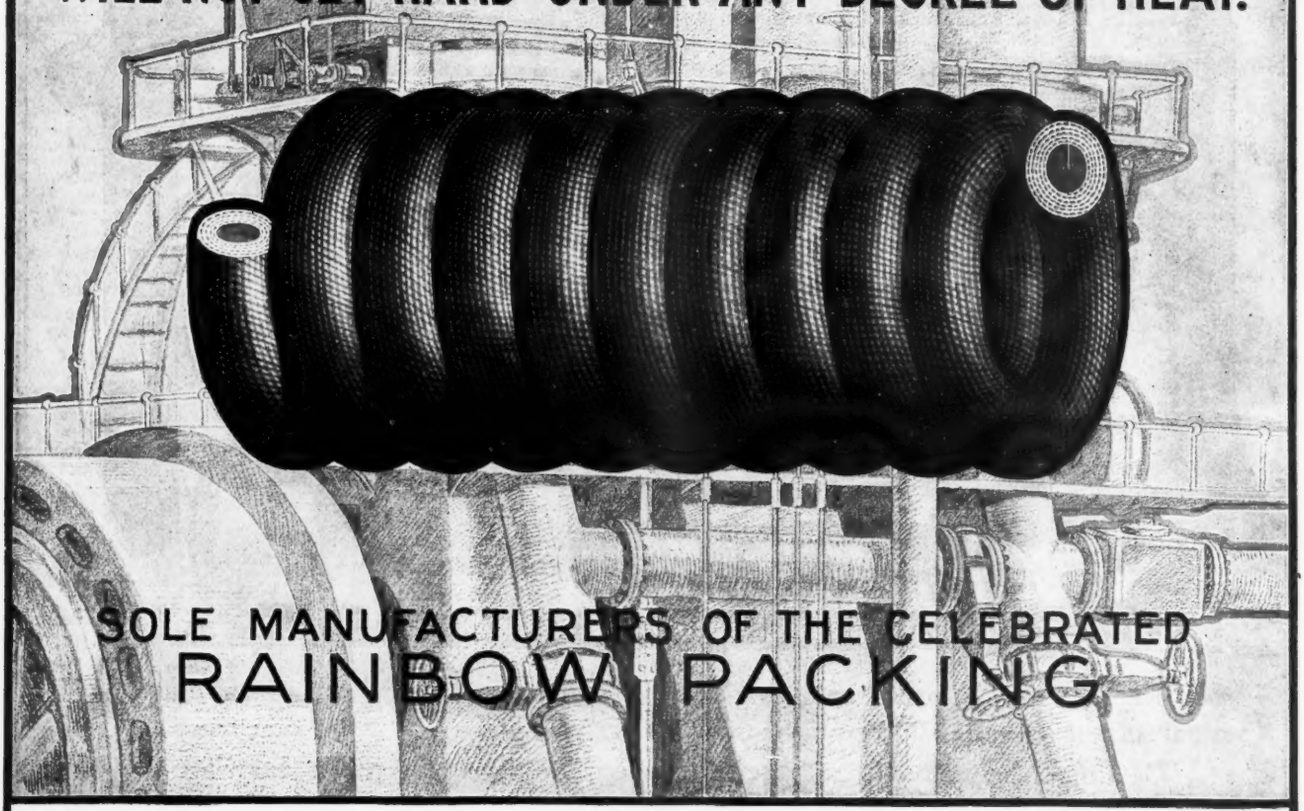

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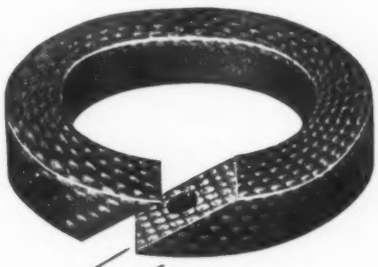

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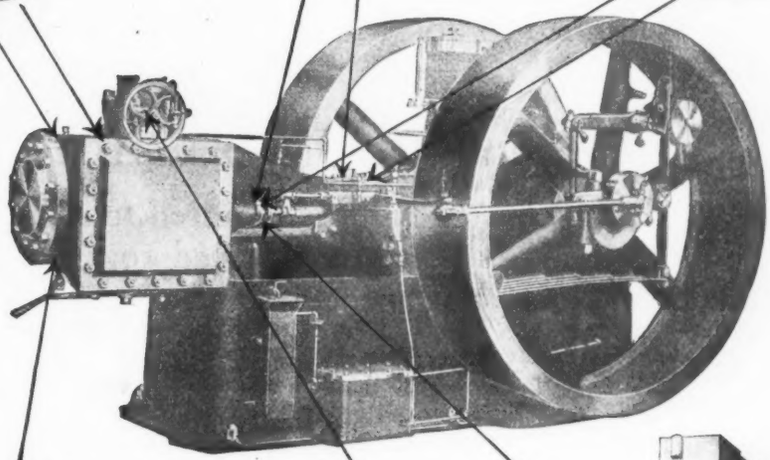

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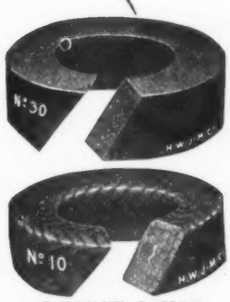

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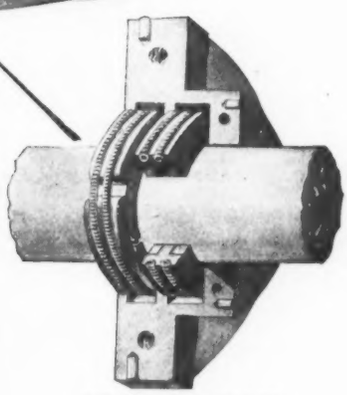

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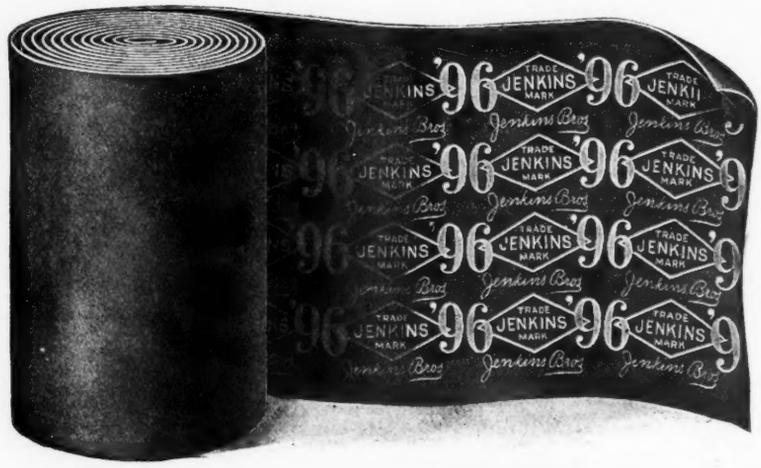

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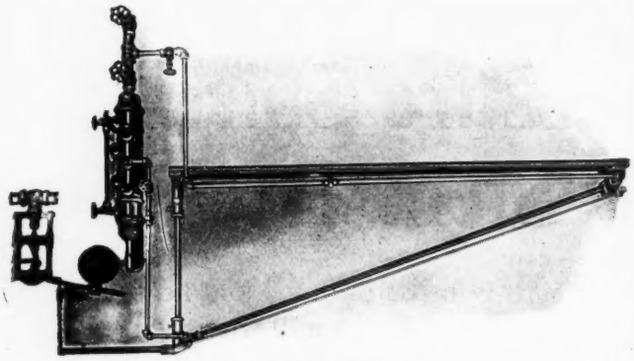

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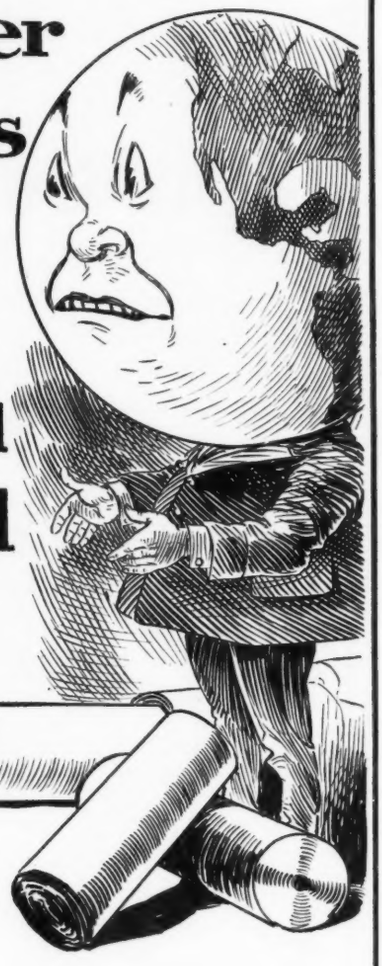

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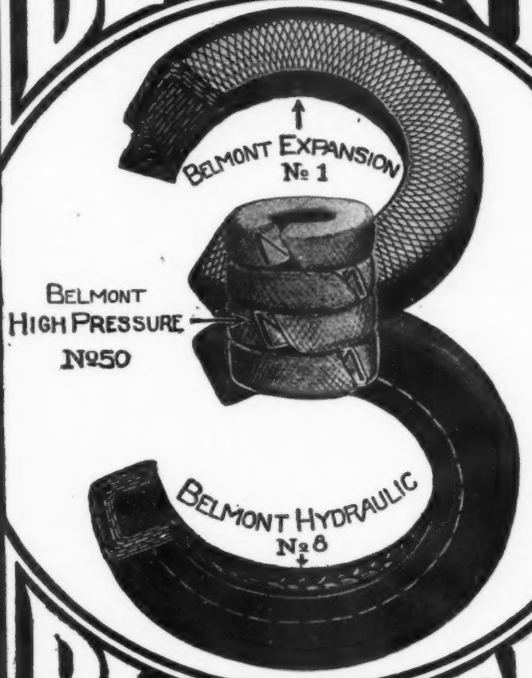

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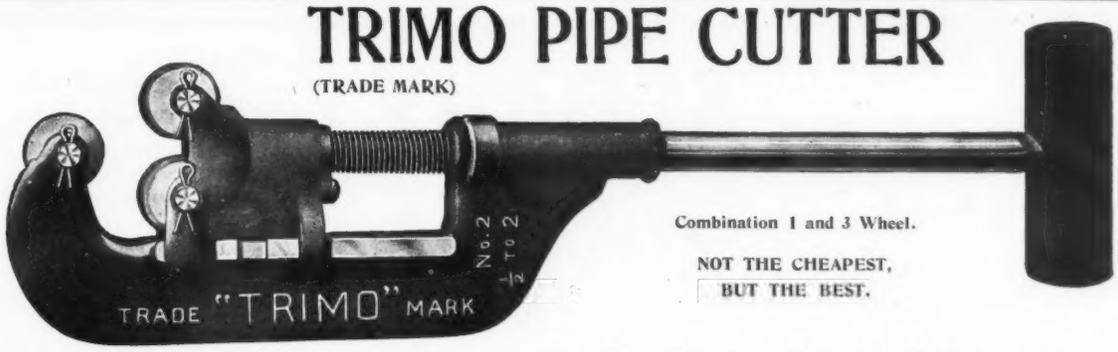

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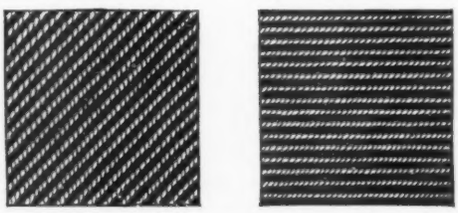

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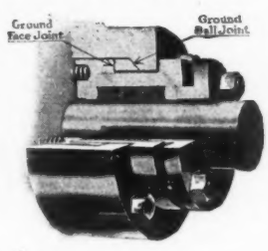

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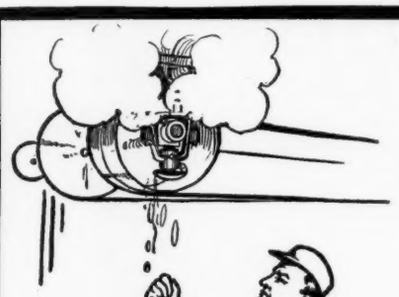

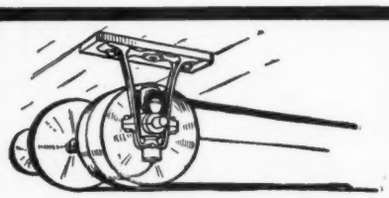

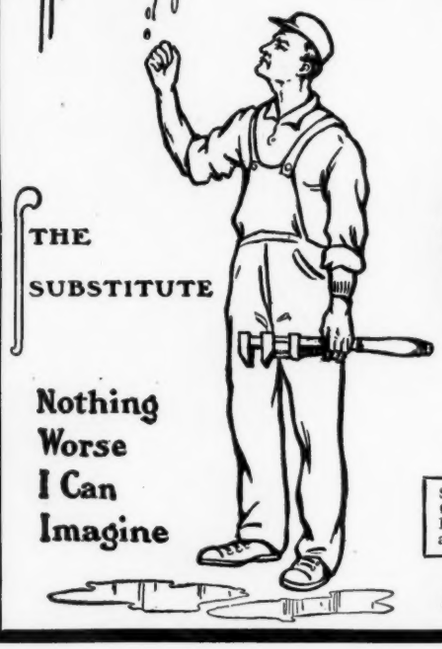

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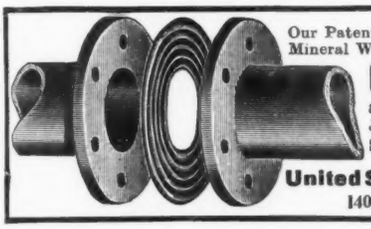

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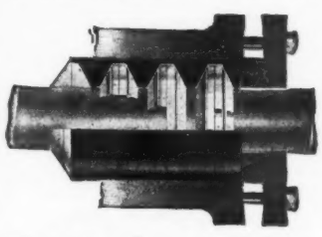

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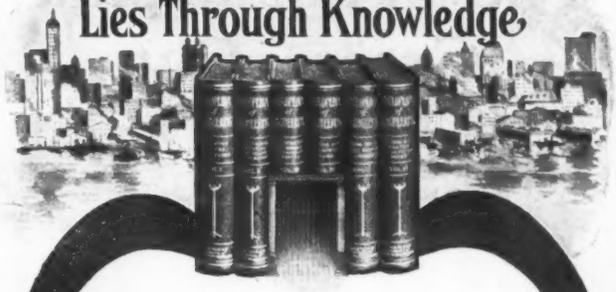

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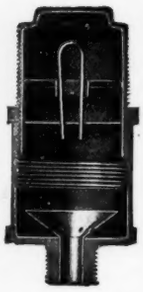

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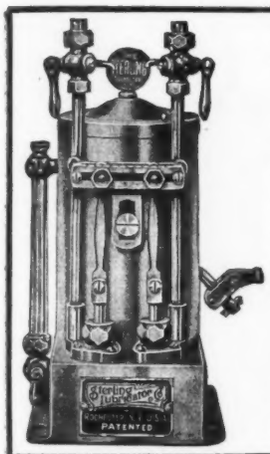

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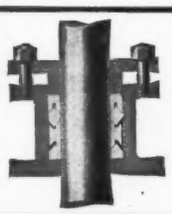

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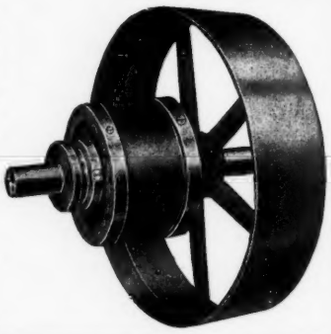

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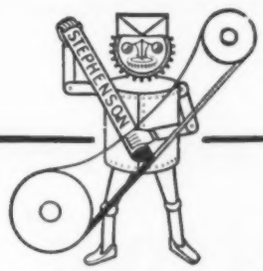

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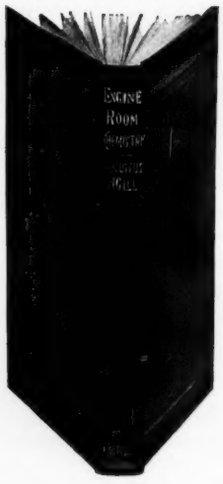

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Williams Double Disc Gate Valve

will fill your needs perfectly no matter how severe the service may be. This valve has two discs and seats — a double protection against leakage — and will take pressure from either side. Of excellent design, heavy construction, it is not effected by the strains of expansion or contraction and will therefore stand long and severe usage. It is the only valve that can be repacked under full pressure of steam or liquids without any danger of being burnt or scalded in the operation.

Be safe and order Williams Valves.

THE D. T. WILLIAMS VALVE CO.
904-910 Broadway, - CINCINNATI, OHIO

3

Is It Policy to Sacrifice The Harmony Of Your Entire Plant Through Careless Installation of Valves?

With wide-awake, progressive business men, **positively no!**

With such men no pipage equipment but the best will pass —**absolutely none but the best at the start!**

A plant equipped right at the start will remain right! A plant equipped right at the start will create safety and satisfaction to all concerned!

Every valve and every piece of pipage equipment made by us is not only right at the start, but IT'S RIGHT FOR ALL TIME! Tuyeres, Tuyere Cocks, Regulators, Traps, Etc., Etc. Send for Catalogue.

PITTSBURGH VALVE, FOUNDRY AND CONSTRUCTION COMPANY

PITTSBURGH · NEW YORK · BOSTON
CLEVELAND · BIRMINGHAM, ALA.

We're Going to Raise Your Salary

"Yes, young man, we find that the training you have applied to your work has been so beneficial to the Company that we are going to encourage your further efforts by raising your salary."

Such scenes as these are actually taking place every day. The man who gets the raise is the **trained** man—the expert—while the untrained man plods along at the same old wages. If **you** are poorly paid and have ambition, there is a practical and definite system by which you can obtain promotion—a system that last year brought over $20,000,000 in increased salaries to the men that adopted it.

You won't have to leave home; there'll be no interruption in your work; there's no age limit; you won't have to buy books; it makes no difference what you do or where you live; lack of capital is no barrier; it makes no difference how scant your spare time may be.

If you are ambitious, mark and mail this coupon **NOW** and find out the most practical way to raise your salary.

INTERNATIONAL CORRESPONDENCE SCHOOLS
Box 979, Scranton, Pa.

Please explain without further obligation on my part, how I can qualify for a higher salary and advancement to the position before which I have marked X.

Electrical Engineer	Machine Designer	Sanitary Engineer
Elec.-Lighting Supt.	Mechanical Draft.	Architect
Elec.-Railway Supt.	Foreman Machinist	Architectural Draft.
Electrician	Foreman Toolmaker	Ad Writer
Telephone Engineer	Foreman Molder	Window Dresser
Civil Engineer	Foreman Blacksmith	Chemist
Bridge Engineer	Marine Engineer	Sheet-Metal Draft.
Mechanical Engineer	Hydraulic Engineer	Ornamental Design.
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Refrigeration Eng.	Surveyor	Stenographer
Traction Engineer	Mining Engineer	Civil Service Exams.

Name _____

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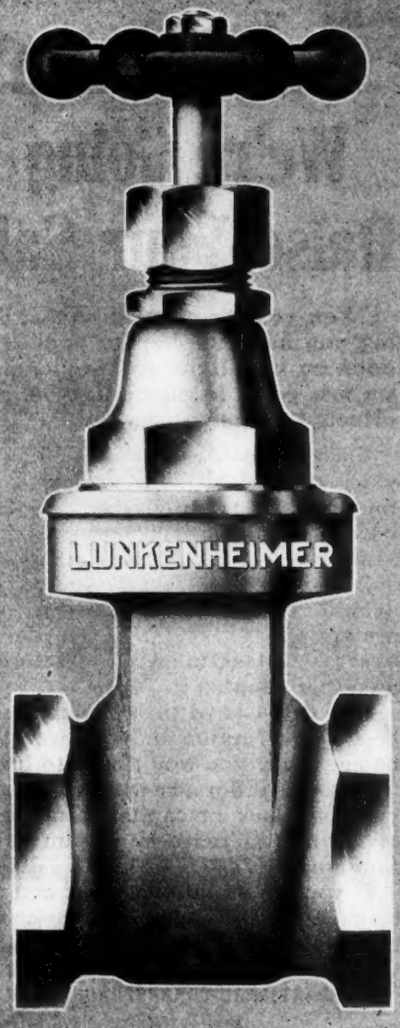
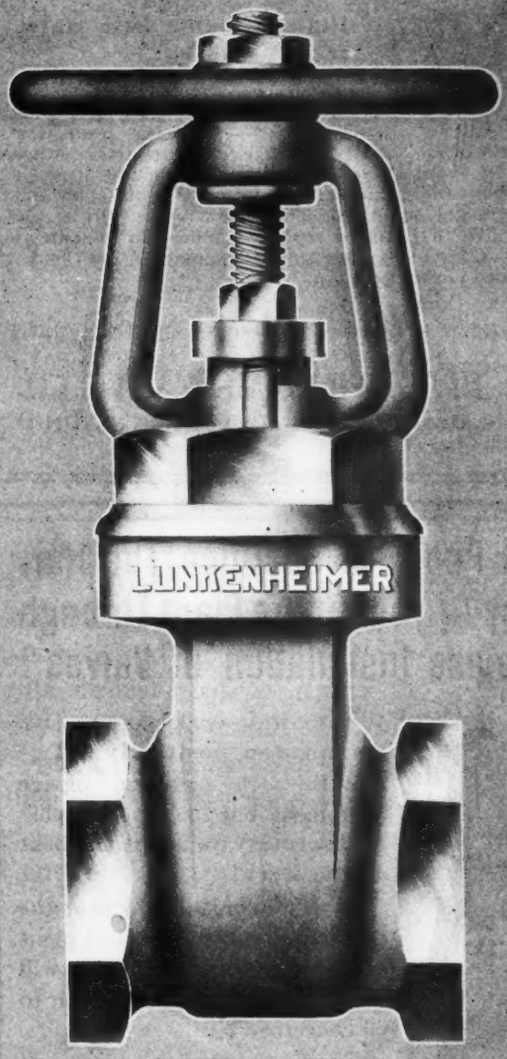
City _____ *State* _____

LUNKENHEIMER WEDGE DISC GATE VALVES

Are made of a BRONZE COMPOSITION SUCH AS IS REQUIRED BY THE UNITED STATES NAVY. They are DOUBLE SEATED and will therefore take pressure from either end. The DISCS and SEATS and all other parts subjected to wear CAN EASILY BE RENEWED. Stuffing-boxes can be packed under pressure; the workmanship cannot be excelled and the valves have full area and are absolutely tight. Made with Outside Screw and Yoke or Stationary Stem; Medium Pattern for working pressures up to 200 pounds and Extra Heavy Pattern for 300 pounds working pressures. Our catalog will tell you more about them. It's free, write for a copy.



STATIONARY STEM



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The Lunkenheimer Company

Largest Manufacturers of High Grade Engineering Specialties in the World

General Offices and Works, Cincinnati, Ohio, U.S.A.

Branches: New York, 66-68 Fulton St.; London, S.E., 35 Great Dover St.; Chicago, Lake and Dearborn Sts.

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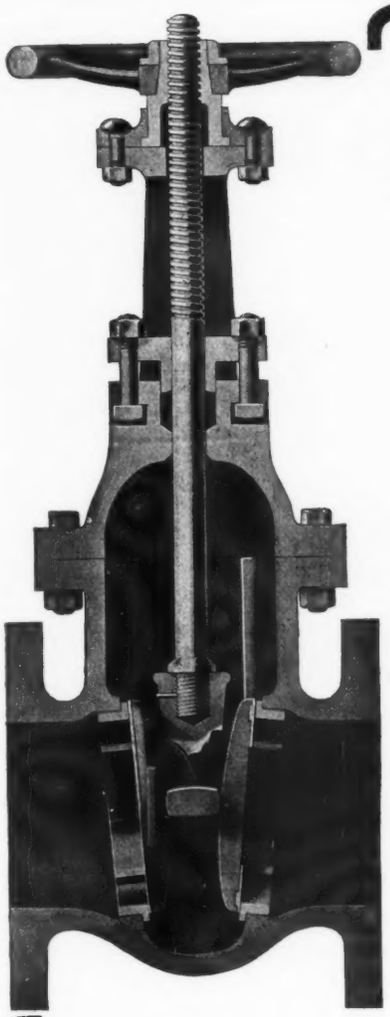


Nelson Valves

Advantages through Simplicity of Design

There are only three working parts in the body of a Nelson Valve—two tapered discs and one wedge. These occupy very small space; the valve body is therefore short, compact and strong, and is not subject to the excessive strains occurring in valves with long bodies.

These three parts act as harmoniously as if cast solid, and, without the usual complicated mechanism, provide a flexibility that compensates for and conforms to any distortion that may occur through expansion, sagging of the line or water hammer, insuring a perfect contact under any conditions.

There is just one way to put a Nelson Valve together, the mechanism being so simple that it is impossible to wrongly assemble it. Bolts are provided at every joint possible, so that, if necessary to take apart at any time, the parts can be easily unbolted without the usual trouble caused by rust when studs are used.

It will be seen that the design is free from complex parts; it retains the simplicity of the single wedge type, but avoids the rigidity and liability to leak that occurs in the single wedge type; it has the flexibility of the most complicated type without the intricate disorderly mechanism.

This simple mechanism also makes it possible for the discs to properly seat without scraping across the valve seats and with less application of power in opening and closing than in any other known type.

They are guaranteed—absolutely and expressly.

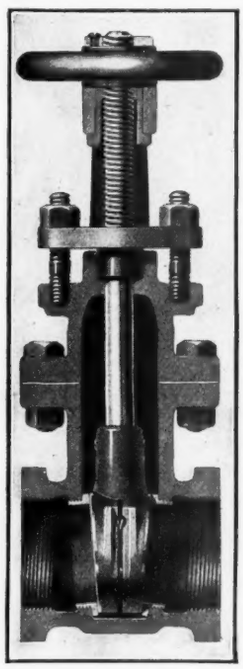
The Nelson Valve Company,
Philadelphia.

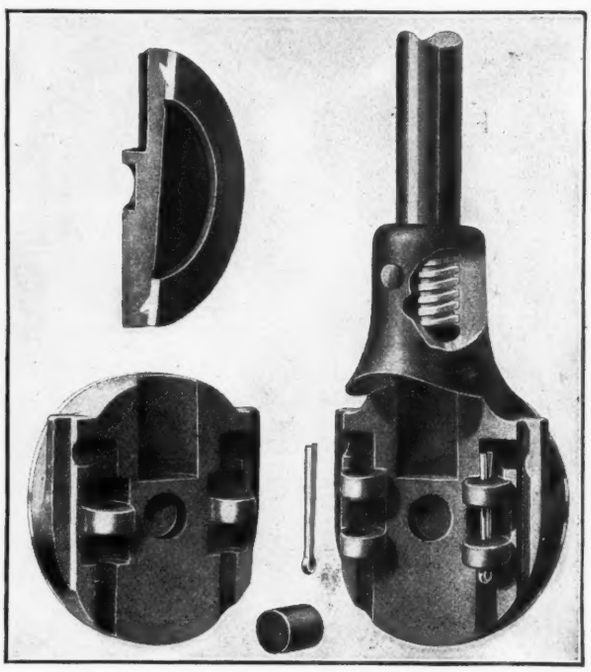
New York, Hudson Terminal Bldg.
Chicago, . . 40 Dearborn Street
Pittsburgh, . 525 Third Avenue
Minneapolis, . . 622 Andrus Bldg.
San Francisco, . Atlas Building
Butte, Mont., . 56 E. Broadway

IF YOU ARE INTERESTED IN POWER PLANT EQUIPMENT YOU WILL BE INTERESTED IN THE

PITTSBURGH IRON-BODY GATE VALVE

for the following reasons:





1 This valve combines the features of both the solid wedge and loose disc valves and does not have the disadvantages of either. This is done by making one of the discs a solid wedge and hinging the other to it as shown in sketch so as to allow both to adjust themselves to the seats.

2 This valve has less wear on the faces of the discs and seats than any other valve made. This is secured by having the discs guided by ribs cast in the body of the valve thus allowing them to lift away from the seat without scraping and abrading.

3 This valve will not leak due to expansion strains from piping because the bosses are drilled and pinned together with cotter pins so loosely that they can move in either direction upon the plug and adapt themselves to the seats whatever the conditions may be as to parallelism.

4 The discs of this valve are faced with steam metal which is forced into an undercut groove in the face of the disc by a special machine using rolling pressure, which both compacts and surfaces the metal.

5 Quality is never sacrificed to secure cheap production. This valve is made of the highest grade material and is finished by skilled mechanics with the latest and most approved machinery that money can buy.

6 Thousands of these valves are in use in all parts of the country and we have never had a complaint.

PITTSBURGH VALVE & FITTINGS CO., General Offices and Works, **BARBERTON, O.**

Pittsburgh Gate Valves are made Standard for 150 lbs. and Extra Heavy for 250 lbs. working pressures. They can be furnished Flanged, Screwed or Hub End, with Non-Rising Spindles or Outside Screw and Yoke. Write for Catalogue.

DAVIS PRESSURE REGULATORS SAVE STEAM

PRESSURE REGULATOR

Do It Automatically

If you are using live steam for heating, drying, cooking or some other purpose at a pressure lower than that carried on the boiler, let the Davis Pressure Regulator make the reduction for you automatically.

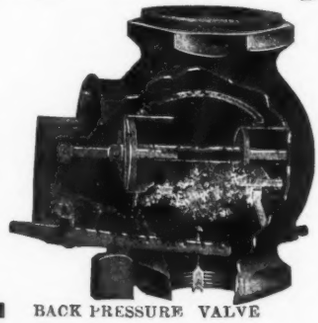
This valve can be adjusted to deliver steam at just the pressure needed and it will maintain that pressure without fluctuations no matter how much the initial boiler pressure may vary.

Reducing steam by throttling through a cracked globe or gate valve is about as satisfactory as using saw dust for fuel. You may be able to get along after a fashion, but why not do it right—automatically.

If you are running your engine non-condensing a Davis Automatic Back Pressure Valve will enable you to make use of the exhaust steam instead of letting it go to waste.

Contrast this valve with its semi balanced disc, small weight and noiseless operation without any possibility of injury to the seats, with the old style single seated valve which pounds like a trip hammer and keeps you poor buying seats for it. Is there any comparison—would you choose the single seat?

Send for a complete catalog of Davis Valve Specialties. It is of interest to both owner and operator.



BACK PRESSURE VALVE

G. M. Davis Regulator Company,

142 Milwaukee Ave., CHICAGO.

BRANCHES—NEW YORK—123 Liberty St. BOSTON—104 High St. ST. LOUIS, 735 S. 4th St.
SAN FRANCISCO—216 California St PHILADELPHIA—56 N. 2nd St.
PITTSBURGH—1206 Park Building.

Reduce Coal Bills

with a Mason Reducing Valve. We'll tell you how when you write.

The Mason Regulator Co., Boston, Mass.

It Only Takes a Quarter Turn to Turn It Off or On.

The Homestead Valve holds the world's record for efficient durability. WRITE.

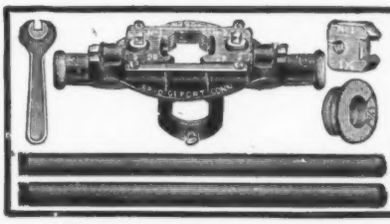
Homestead Valve Mfg. Co.

Brass Founders. Pittsburg, Pa.

Erwood Swing Gate Valves

Manganesite Paste for Joints

WALCH & WYETH, 87 Lake St., Chicago.

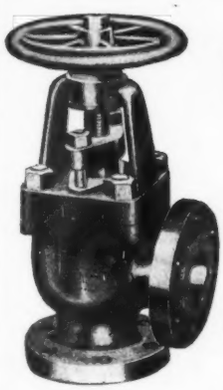


STOCKS AND DIES
PIPE MACHINES,
PIPE CUTTERS,
VISES.

Manufactured by

The Armstrong Mfg. Co.

287 Knowlton St.,
BRIDGEPORT, CONN.



Manufacturers of the

EDWARD VALVE

For High Pressures,
Superheated Steam and Water.

THE LAMMERT & MANN

Oil Dash Pots for Corliss Engines,
Gas and Gasoline Engines.

LAMMERT & MANN,

ENGINEERS and MACHINISTS,

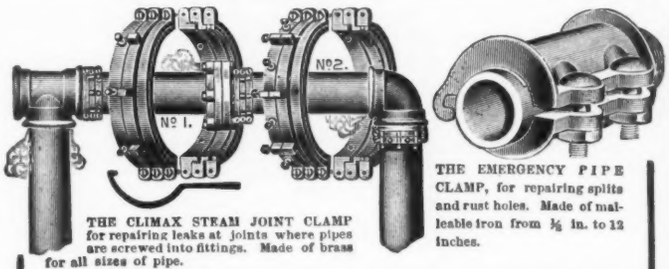
157 S. Jefferson St. CHICAGO, ILL.

EMERGENCY WORK IN POWER PLANTS MUST BE DONE IN A HURRY.

"TOLEDO" Pipe Threading Devices

thread pipe up to 12". ONE MAN can do it quickly and *in any place, in any position.* An invaluable line of tools. Let us tell you about them.

The Toledo Pipe Threading Machine Co.,
TOLEDO, OHIO.



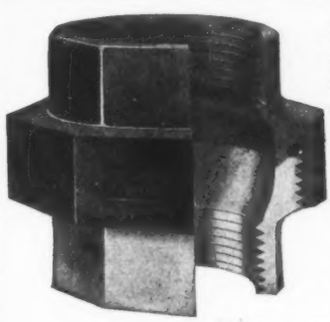
THE CLIMAX STEAM JOINT CLAMP for repairing leaks at joints where pipes are screwed into fittings. Made of brass for all sizes of pipe.

THE EMERGENCY PIPE CLAMP, for repairing splits and rust holes. Made of malleable iron from ⅛ in. to 12 inches.

PIPE REPAIRS FOR ANY CONDITION

Send for Catalog of
STEAM SPECIALTIES

JAMES McCREA & CO.,
MANUFACTURERS,
61 West Washington Street, Chicago.



Connections Made Easy

It's easy to connect and disconnect "Kewanee" Unions. They won't stick or rust and need no pounding because they have brass to iron thread connection and cannot rust together. The ball-joint seat makes the "Kewanee" absolutely tight without a gasket. Ask for information.

National Tube Co., Pittsburg, Pa.

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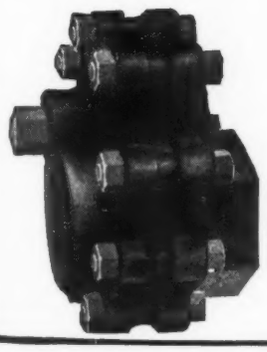
EVERLASTING BLOW-OFF VALVE



Straight-through flow. No stuffing-box. Easily operated. Self-cleaning; self-grinding seats. Easily repaired. Send for descriptive booklet and prices.

SCULLY STEEL & IRON CO.,

CHICAGO

J. B. HACKETT, 5 TEMPLE COURT, NEW YORK REPRESENTATIVE.

NO MORE BURNS

resulting from fishing around in live steam and scalding water when the gauge glass breaks, PROVIDED you use

The "P. B. H." Quick Closing Water Gauge.

In case of accident to the glass, a simple pull on the chain cuts off the steam and water **instantly** and with **perfect safety** to the engineer.

Try the "P. B. H." for 30 days. Write for circular.

The Paul B. Huyette Co.,
2025 Betz Building, Philadelphia, Pa.

There's Accuracy In Every Ashton Gage

Ashton Steam, Vacuum and Recording Gages are made of the highest grade material, handled by the most skilled labor, and are guaranteed to be the most practical, efficient and durable gages on the market.

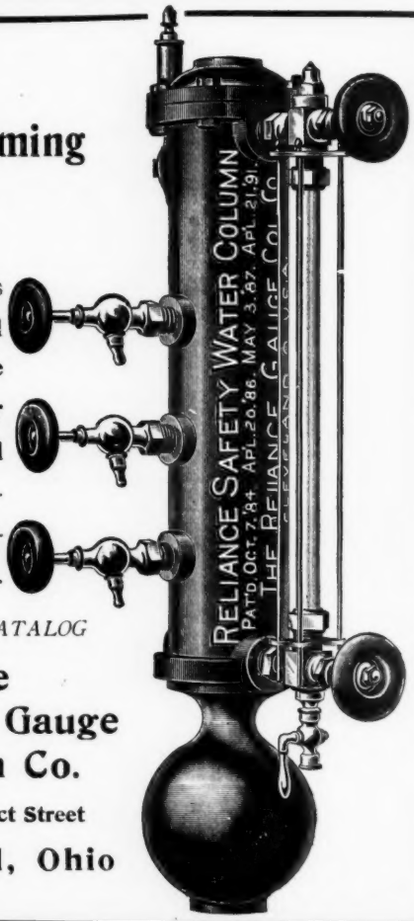
Their use invariably raises the efficiency standard of the entire plant, prevents errors, and points out many new ways to save.

Write for Catalog "P"

The Ashton Valve Company,
Boston New York Chicago
St. John's House, London, E. C.

An Overwhelming Majority

of all the boilers in use are fitted with **Reliance Safety Water Columns** and find in them investments paying 100% yearly.

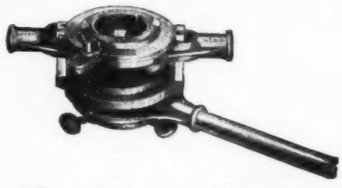


ASK FOR CATALOG

The Reliance Gauge Column Co.
75 E. Prospect Street
Cleveland, Ohio

"BEAVERS" are the proper die stocks for use about factories

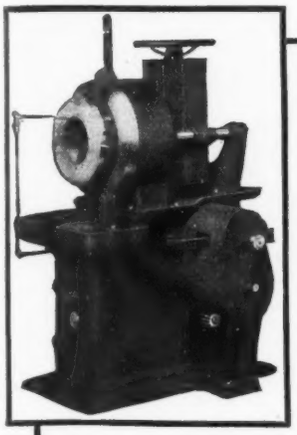
BECAUSE they are built on the easy working principle, enabling one man to thread any size pipe without calling for help.
Each Stock threads all sizes of pipe within its range without changing dies so you have no loose parts to carry around or get lost or misplaced.
And consider the time you save by not having to change dies.
They are a time proven success and of such practical advantage in saving time and labor as to compel their use from an economical standpoint once you realize it.



"Beaver" 1" to 2" Ratchet Stock.

Made in all sizes ¼" up.
Sold by all Jobbers subject to 10 days' trial.
We would like to send you descriptive matter.

THE BORDEN COMPANY
WARREN, O.



Power Pipe Threading Machinery

Belt—Motor—Gas Engine Driven

Loew Victor Model 1908

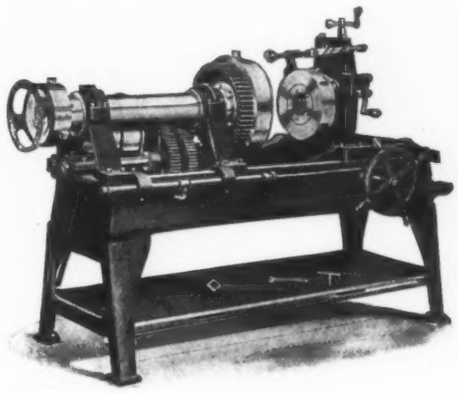
Built to take care of same class of work as heavy lathe—bed types, and has the advantage of reduced size (which means lower cost), less floor space, and portability, besides the improved features which are to be found only in the Loew Victor.

Catalog on request.

The Loew Manufacturing Co.

Cleveland, Ohio.

Eastern Representative, N. G. Rost, 39 Cortlandt St., New York.
Pacific Coast Representative, W. S. DePierres, 247 Pine St., San Francisco.



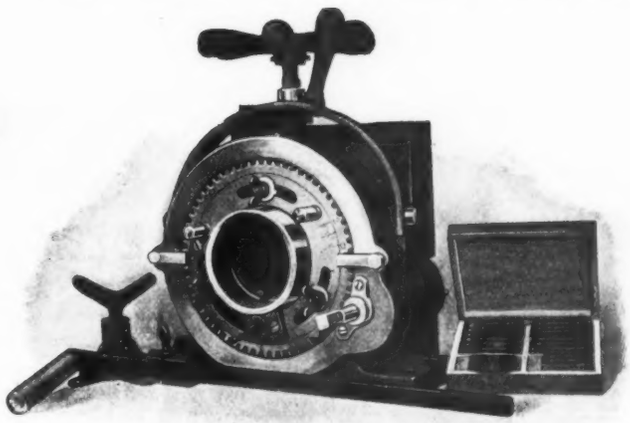
GOOD THREADS

may not be an absolute necessity if you use plenty of cement, yet there is no denying the fact that it is *better* to have *good* threads. Some may be satisfied with poor threads, but if you are a sticker for good ones, do your threading on a B. & K. PIPE MACHINE. *Yours for good threads.*

Bignall & Keeler Mfg. Co.
Edwardsville, Ill.

THE ONLY MACHINE!

The Forbes Patent Die Stock



Compact Portable Simple Strong

The *only one-man machine* that can cut and thread pipe up to 15″ dia. by hand.
The *only machine* with receding gear carrying the dies onto the pipe.
And the *only machine* in which the shell can be adjusted to take up the inevitable wear. Write for Catalog.

THE CURTIS & CURTIS COMPANY,

85 GARDEN STREET, BRIDGEPORT, CONN.

The New Model Roney Stoker

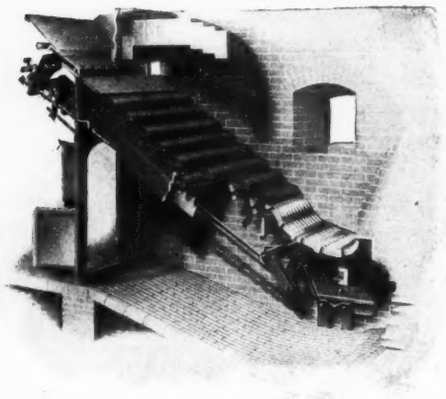
is fundamentally the same as the old standard

with improvements suggested by twenty years' experience in the field.

The grate bars have been reduced one half.

Twenty square inches of surface is exposed to cold air currents for every pound of iron exposed to heat.

Incoming air cools the arch, and is at the same time heated, preventing smoke.



New Model Roney Stoker in Perspective

The Westinghouse Machine Company

Steam Turbines, Steam Engines, Gas Engines, Gas Producers, Storage Batteries and the Roney Stoker

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Atlanta, Candler Building.
Chicago, 171 La Salle Street.
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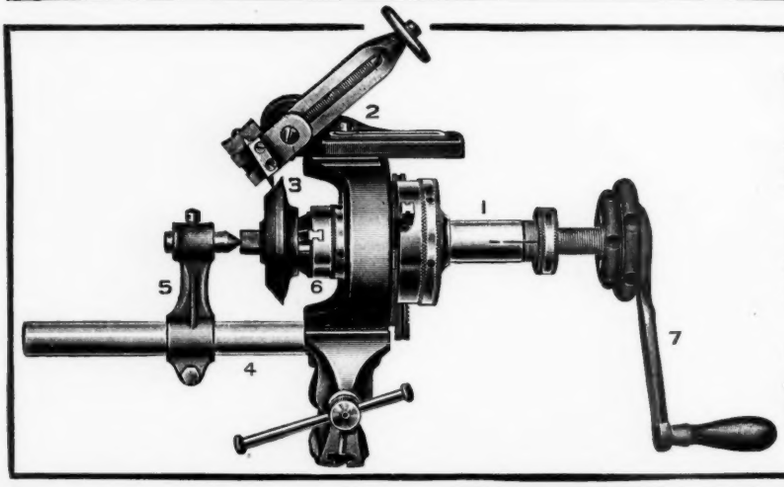
Pittsburg, Westinghouse Building.
Philadelphia, North American Bldg.
Denver, 512 McPhee Building.
San Francisco, Hunt, Mirk & Co.



You Want Proof

that a machine will do your work before you buy it.

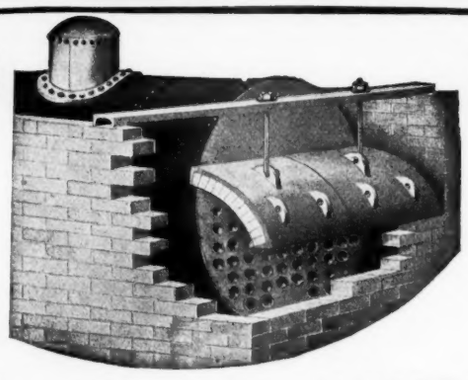
You can prove to your entire satisfaction that a Dexter Machine will reseat your leaky valves by trying a machine 30 days.

Send for Catalog P telling all about them.

THE LEAVITT MACHINE CO.,
ORANGE, MASS., U. S. A.

An Iron Backing

faced with fire brick or other similar material and the Monarch Boiler Arch is provided with Attachments for hanging from above instead of resting against the brick work.



A Concrete Guarantee

insures you satisfaction or your money back. When writing for prices give size of boiler, distance between side walls and from boiler head to rear wall.

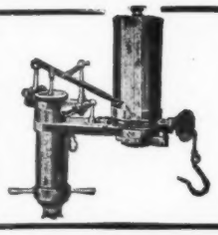
CATALOG?

Mayville Specialty Mfg. Co., (General Founders and Machinists) **Mayville, Wis.**

MARTIN GRATES

Martin Anti-Friction Rocking Grates will burn slack coal and get the same steam results as ordinary grates do with best lump coal. Catalog tells why.

MARTIN GRATE COMPANY, 281 Dearborn Street, CHICAGO.



A HIGH GRADE INDICATOR

at a low price and furnished on ten days' trial. If not entirely satisfactory it will not cost you one cent.

THE TRILL INDICATOR COMPANY

Eagle Street CORRY, PA.

JEFFREY TELESCOPIC ASHES ELEVATOR.

Jeffrey

Coal and Ashes Handling Systems for Power Plants.

THE JEFFREY MFG. CO., COLUMBUS, OHIO.

New York Chicago Boston St. Louis Denver Pittsburgh Montreal Knoxville

NOTICE

Suit brought by this Company is pending in the United States Courts against makers of so-called Multivane Fans. No guarantee can protect buyers of an infringing fan in the use of same after an adverse decision of the courts. Our patent rights will be protected to the fullest extent of the law.

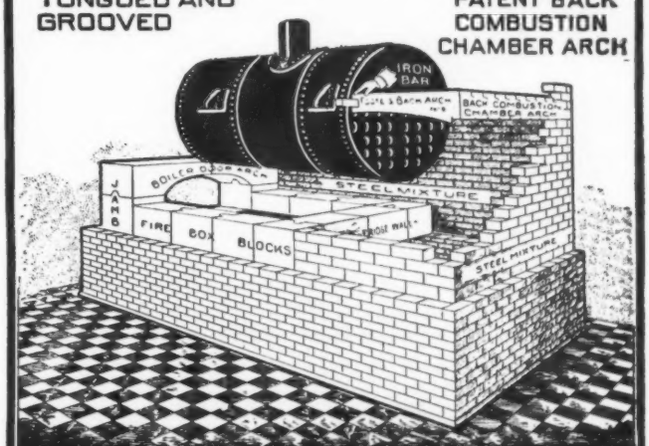
SIROCCO ENGINEERING CO.
138-140 Cedar Street
NEW YORK

"STEEL MIXTURE"

BOILER DOOR ARCHES AND FIRE BOX BLOCKS

TONGUED AND GROOVED

PATENT BACK COMBUSTION CHAMBER ARCH



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McLEOD & HENRY CO.
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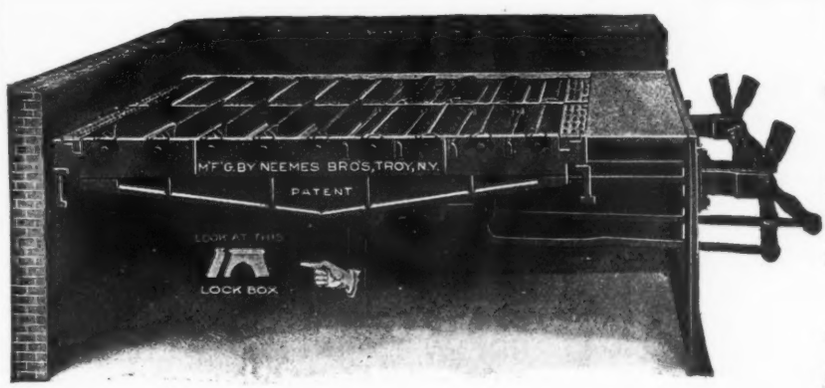
BRANCH OFFICE, 1402 BROADWAY, NEW YORK CITY.



NEEMES BROS.

IMPROVED

Clinker Cutting, Shaking and Dumping Grate

unlike all other grates will cut from both sides of the shaker alike. Makes more steam with cheaper fuel and less of it. A slight agitation shakes out the ashes or a full opening dumps everything into the ashpit. *Write.*

NEEMES BROS.,
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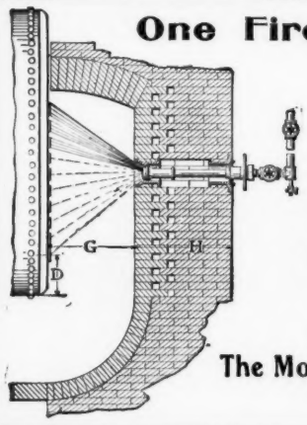
C. W. VAN BLARCOM, Room 533, Terminal Bldg., 30 Church St., Agent for New York City and vicinity BABCOCK & WILCOX, Ltd., Montreal, Canada, Sole makers for Canada BURKE ENGINEERING CO., 311 Industrial Bldg., Providence, R. I., Sole Agents for the New England States.

NO MORE BLACK SMOKE. NOT AS MUCH FUEL.
And No Loss Of Efficiency With
WILKINSON'S AUTOMATIC STOKER
THE WILKINSON MANUFACTURING CO., BRIDGEPORT, MONTGOMERY CO., PA.



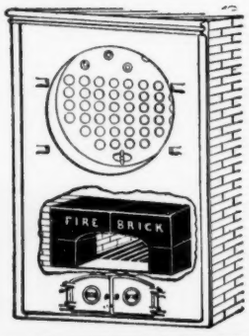
One Fireman in Five Minutes

Can thoroughly clean all the flues of your boiler after you install the Monarch Blower.
By doing this three or four times a day you will keep your equipment up to its highest efficiency.
Write.
The Monarch Steam Blower Co.
Troy, New York

ANY TYPE OF BOILER
The Murphy Automatic Smokeless Furnace
burns slack and other low cost fuels with unexcelled economy and absolute smokelessness. Strictly automatic in feeding and distribution of coal and the removal of the ash. Send for a complete description.
MURPHY IRON WORKS, 5 Walker St., DETROIT, MICH.
UNITS OF ANY SIZE

Wing's Turbine Blower
FOR FORCED DRAFT
Most Efficient Most Compact Catalog?
L. J. WING MFG. CO., 90 West Street, NEW YORK

Your Boiler Settings

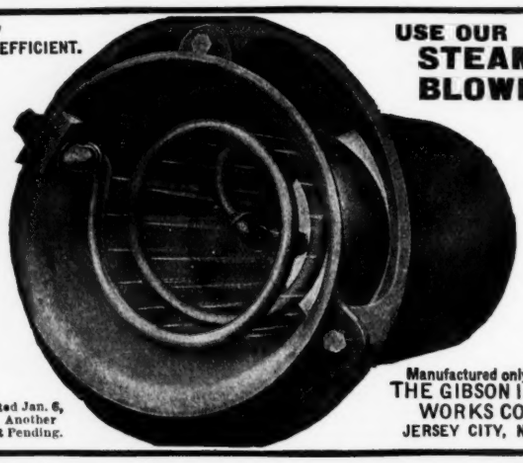


require the protection of perfect fire brick
Write for prices.
Presbrey Fire Brick Works
Taunton, Mass.

PREVENT SMOKE
Write to us for descriptive matter relating to a device that is mechanically correct, simple in construction, absolutely automatic, and its effectiveness in preventing smoke from Bituminous coal under any and all conditions has been fully demonstrated.
CLIMAX SMOKE PREVENTER COMPANY
205 Equitable Building, **Boston, Mass.**

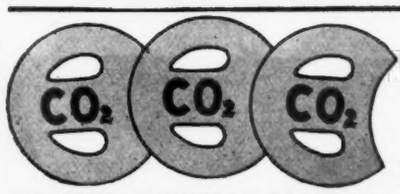
***The* Most Efficient Commercial Fan is Built by**
B. F. STURTEVANT CO., Boston, Mass.
General Office and Works—Hyde Park, Mass.
NEW YORK PHILADELPHIA CHICAGO CINCINNATI LONDON

VERY EFFICIENT.
USE OUR STEAM BLOWER



Patented Jan. 6, 1903. Another Patent Pending.
Manufactured only by THE GIBSON IRON WORKS CO., JERSEY CITY, N. J.

FULL FIRE CLAY LINED CONCRETE
"Chimneys"
WIEDERHOLDT CONSTRUCTION CO.
American Trust Bldg., Chicago, Ill.



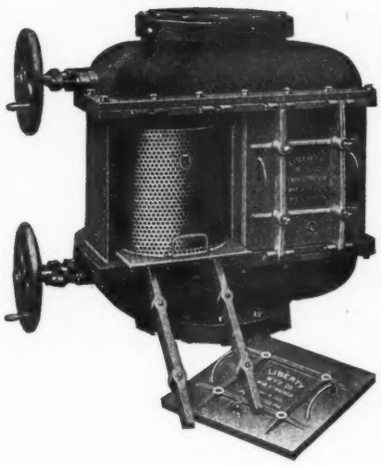
C-O-Two Tile
FIRE ARCHES
Any Rise, Any Span,
Air Baffle Mixing System
produces
RESULTS
C-O-TWO FURNACE COMPANY, Syracuse, N. Y.

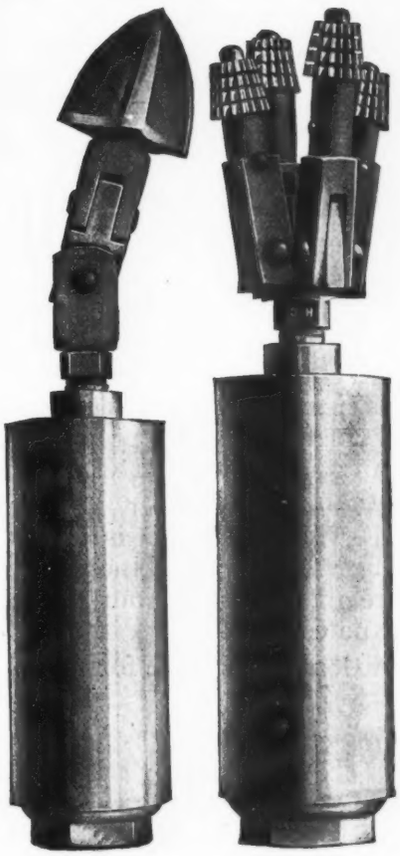
Over 7500 Hammel Oil Burners
In use under Stationary Boilers, Locomotives, Kilns, Etc.
Write for Circular of Hammel Patent Furnace for Water-Tube Boilers
HAMMEL OIL BURNER CO.
609 North Main Street, LOS ANGELES, CAL.

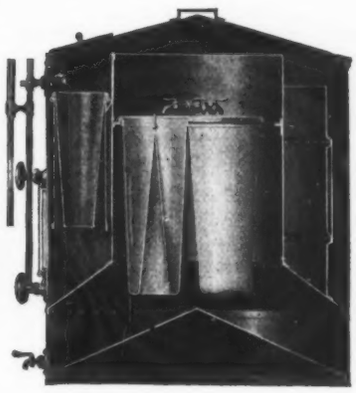
GREEN TRAVELING CHAIN GRATES
AUTOMATIC SELF CLEANING SMOKELESS
GREEN ENGINEERING CO.
COMMERCIAL NATIONAL BANK BLDG., CHICAGO.
GENERAL FOUNDY WORK A SPECIALTY

LIBERTY

Lightens The Power Plant Expense







The cut shows our **Twin Strainer** with one side open ready for cleaning while the other side continues to safeguard the pipes, pumps, etc.

No matter how full of foreign matter your water may be the **Twin Strainer** will take care of all of it all the time.

The settling chamber of a Liberty Oil Purifier does 90% of the purifying thus reducing the work of the filtering material, decreasing the operating costs, and prolonging the efficiency of the purifier.

It is neither a washing process nor a strainer but a small oil refinery.

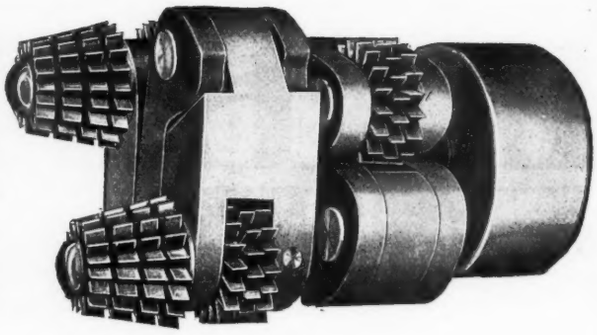
Just one use of Liberty Turbine Cleaners will often repay their cost. Sum up these items; 15% of fuel saved by clean tubes, tubes themselves saved from chemical action of compounds, cost of compounds saved and less time required by use of Liberty Cleaners.

Write for Liberty Catalogs.

LIBERTY MANUFACTURING CO.,

6509 SUSQUEHANNA ST., PITTSBURG, PA.

THE BUSINESS PART OF A BOILER TUBE CLEANER IS THE CUTTINC HEAD



and just as with men, the headwork determines the success of the cleaner.

Ordinary tube cleaners have weak heads. The arms are flimsy, and too light to dig into the hard scale, and by the very nature of their mechanical movement wear out of line rapidly. You know this if you have us d a "spider leg" turbine, and you know that light arms only make repair expenses. Look at the head of this new

WEINLAND WING ARM TURBINE CLEANER

and you can easily see why it is the most successful and the longest lived.

Our new WEINLAND WING HEAD has stronger arms and pins, larger bearings, and more cutting surface at work than any other turbine. The sets of cutter wheels travel in three different zones and each arm works independently of the others, thus making practically four distinct cleaners in one. That is why we can guarantee WEINLAND TURBINES to do their work more thoroughly than any other and in less time and with less wear.

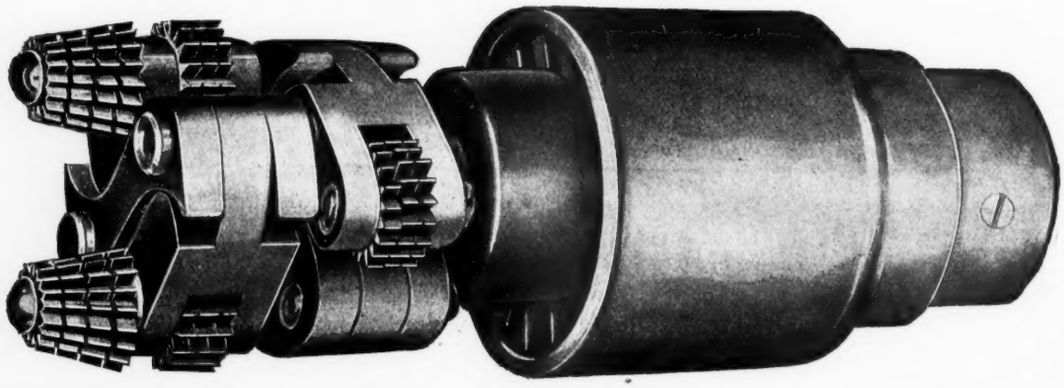
The WEINLAND WING HEAD is furnished with all new Weinland Turbines, but can be used with turbines now in use. For very severe scale or where there are many boilers, our new Steam or Air Driven Mechanical Cleaner cannot be equalled.

Tell us your conditions, and write for prices.

THE LAGONDA MFG. CO., Springfield, Ohio.

Makers of Lagonda Reseating Machines, Automatic Cut-Off Valves and Boiler Tube Cutters.

New York Philadelphia Pittsburg Chicago San Francisco Birmingham Toledo London



[69]

CONTRACTORS.
CENTRAL STATION HEATING.

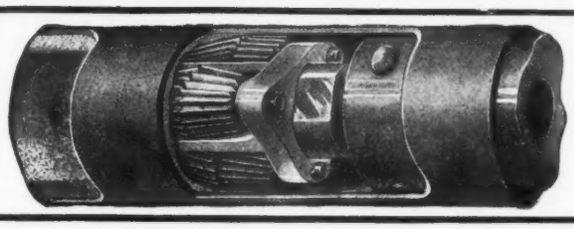
Write for valuable information.

AMERICAN DISTRICT STEAM CO.,
Lockport, N. Y. Toronto, Can. Chicago.

THE HAWK-EYE BOILER COMPOUND NEVER FAILED.

See our Advertisement in First Issue Every Month.

HAWK-EYE COMPOUND CO.,
303-304-305 Merrick Block, CHICAGO, ILL.

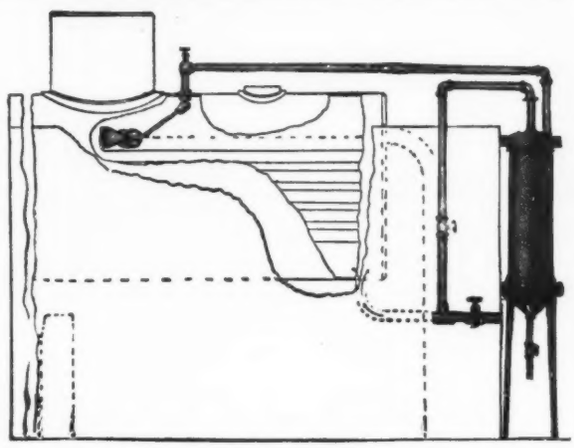


A Water Tube Cleaner Which Must Get All the Scale

Here is the front half of "DEMON" cleaner. Notice that its cutters are not thrown out by Centrifugal action but are *held fixedly* to the full size of tube.

Every tube *must* be cleaned perfectly. Don't fail to write for circular No 54, "Demon Cleaners vs Other Cleaners." Circular No. 56 describes the curved tube "DEMON," Folder No. 30 tells about the "TORPEDO" fire tube cleaner.

THE GENERAL SPECIALTY CO., 887 Niagara St., BUFFALO, N. Y,



No More Need For Boiler Compounds Or Mechanical Cleaners

With the Buckeye Boiler Skimmer you remove the scale-forming material before it ever has a chance to be deposited and the cost is a trifle compared with the saving. Write.

Buckeye Boiler Skimmer Company,
South End, Toledo, Ohio.

FIVE POUNDS OF SCALE PER HOUR

may easily collect in a 250 H. B. Boiler, or if running condensing, enough oil and grease from the condensation, though less in quantity, may become even a greater menace.

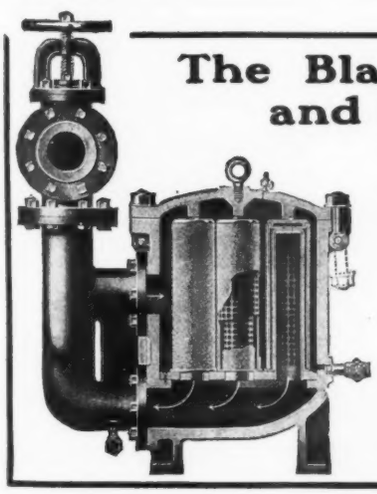
BIRD-ARCHER BOILER COMPOUNDS

will not only prevent this matter from adhering to the heating surfaces, but actually pay big dividends by cutting scale prevention to the lowest possible cost, by keeping boiler capacity high and heating surfaces clean and by doing away with the delays and repair expenses which always result from scale formation.

Sold on a "NO CURE, NO PAY" basis.

WRITE FOR CATALOG.

THE BIRD-ARCHER CO., 90 WEST ST. NEW YORK



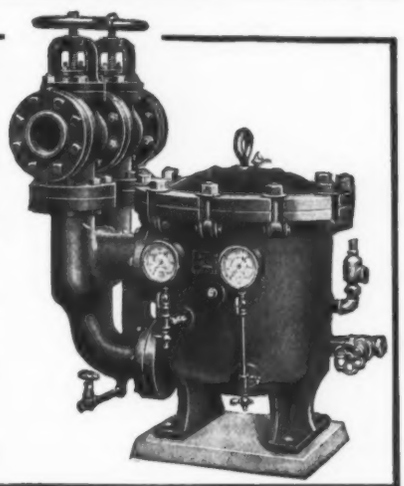
The Blackburn-Smith Filter and Grease Extractor

is practically two filters in one, for every drop of water must pass through two separate and distinct Terry filtering surfaces. If your feed water contains sediment, slime or particles of oil or grease, this filter will pay for itself by stopping repair bills and saving coal.

The Blackburn-Smith Filter can be cleaned or removed almost entirely without touching the feed line, and as the filtering media can be used over and over the first cost is practically the last.

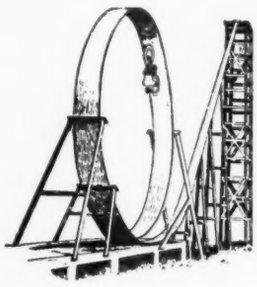
Tell us your feed water troubles and we will tell you the remedy.

JAMES BEGGS & CO.
106 Liberty St., New York City



ALL "SWARTWOUT" APPARATUS

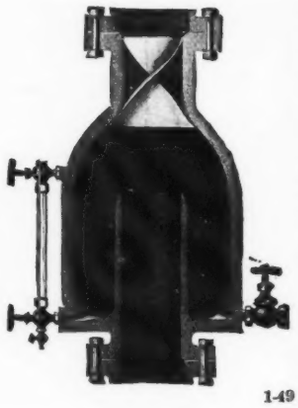
operates on the Helico-Centrifugal Principle. The helix sets the steam a whirling and gives centrifugal force a chance to act. As simply and as marvelously as the rider loops the loop, the water or oil is thrown out of the stream of steam, and settles in the outer chamber whence it is easily drained. The steam flows directly on without an ounce loss of pressure. The water which weighs hundreds of times more than the steam must be separated. It can't help it.



The Ohio Blower Co.

CLEVELAND, OHIO

Also manufacturers of "Swartwout" Gravity-Closing Ventilators



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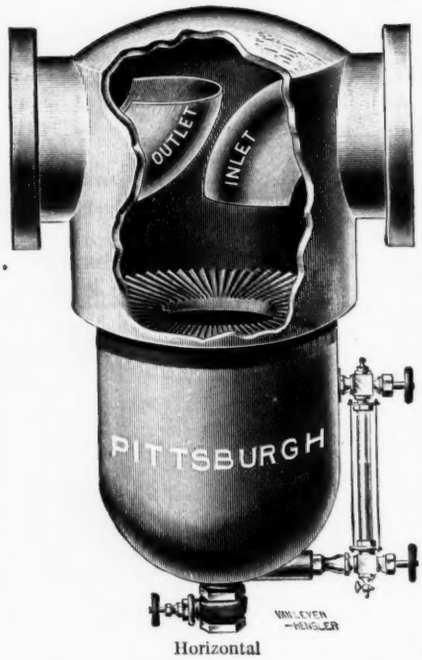
"Pittsburgh" Steam Separators



Horizontal

For Live or Exhaust Steam

Utterly Simple **Perfectly Effective**

Highest Efficiency—
Proved by Laboratory Tests.

No Baffle Plates—
To Cause Spattering Back.

No Contracted Areas—
To Retard Freedom of Flow.

No Small Passages—
To Foul and Clog.

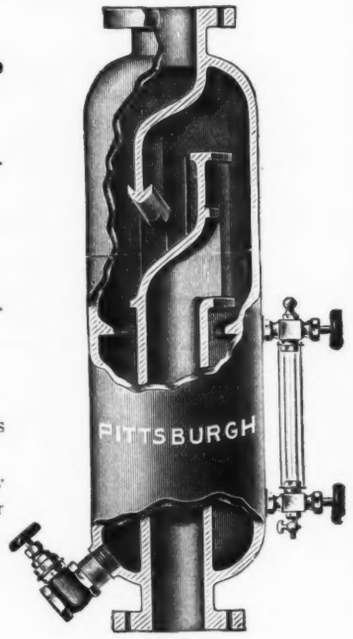
Perfect separation secured by sudden changes in direction of steam flow.

Separated water and oil drained directly away from steam current and into protected receiver space.

Horizontal and Vertical Types

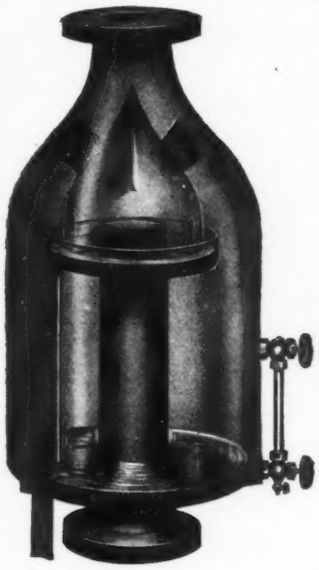
Plain and Receiver Styles

Made in all sizes—Shipped on Guarantee Trial.



Vertical

Pittsburgh Gage & Supply Co., Pittsburgh, Pa.



HOPPES

STEAM SEPARATORS

HAVE A PRINCIPLE OF THEIR OWN.

They contain no baffle plates or tortuous passages to wiredraw the steam or atomize the water of entrainment, but troughs partly filled with water intercept the entrainment and same is carried to the bottom of separator by drain pipe as shown in cuts.

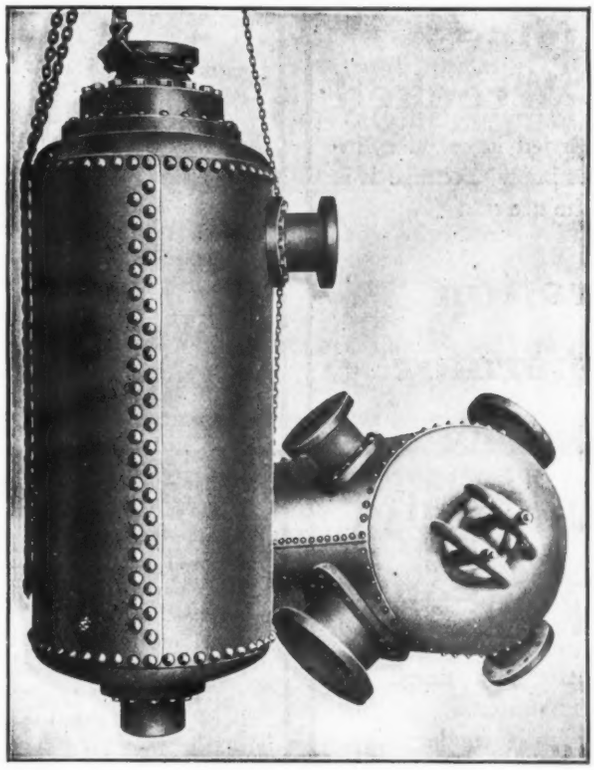
The bodies of Hoppes Separators are very large and afford a large storage of steam near the cylinder of engine, increasing its efficiency and protecting it from flushes of water from the boilers which so frequently wreck engines.

Standard Cast Iron Type are cast in one piece, sizes 1″ to 9″ inclusive, horizontal and vertical.

Standard Steel Shell Receiver Type, sizes 6″ to 20″ inclusive, vertical, horizontal and angle designs.

SPECIAL RECEIVER SEPARATORS.

Built in all sizes and designs and for any steam pressure, with the number and location of openings to suit conditions, each machine embodying the *Hoppes principle* of separation.



Send us specifications covering your requirements and we will submit prices and blueprints of separators to meet them. Every Hoppes separator is *guaranteed* to deliver 99% or better dry steam.

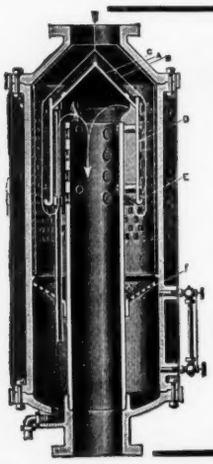
Live Steam Feed-Water Purifiers.
Exhaust Steam Feed-Water Heaters.

Write for Catalog

Oil Eliminators.
Cast Iron Exhaust Heads.

Write for Catalog

HOPPES MFG. CO., 19 Larch St. SPRINGFIELD, O.



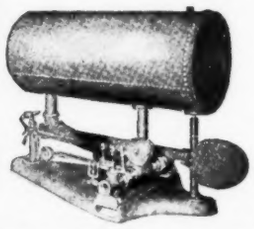
SWEETS

Steam Separators deliver 99.8 dry steam and oil separators remove 99% of oil from exhaust steam. They *do* it that's all. All styles.

DIRECT SEPARATOR COMPANY,

712 S. Geddes St., Syracuse, N. Y.

Nothing Complicated



All working parts of the

Morehead Steam Trap

are outside, in plain view and easily accessible. This Trap operates entirely by gravity and is consequently unfailing.

Write for details.

MOREHEAD MANUFACTURING CO.
1051 Grand River Ave., Detroit, Mich.

A Money back Proposition

After a 30 days' trial—if you are not convinced that the Baum Separator will prove a profitable investment we will return your money and pay for returning the separator.

Send for new Catalogue and prices.

HERSHEY MACHINE & FOUNDRY CO.
MANHEIM, PA., U. S. A.

W. G. Ruggles Co., 54 High St., Boston, Mass.
R. D. Bliss, 40 Dearborn St., Chicago, Ill.

To Your Entire Satisfaction

The Anderson Improved Steam Trap will discharge, without loss of steam, the water from steam pipes, coils, dryers, etc. It is always locked with at least three inches of water.

Write

THE V. D. ANDERSON CO.,
1935 West 96th Street CLEVELAND, OHIO.

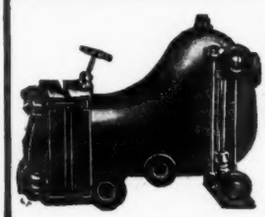
How Many Engines Have Been Wrecked

by an excess of water being carried into the cylinder? It would be interesting to know, because it is absolutely inexcusable when the use of a

Stratton Separator Assures Absolutely Dry Steam

no matter how much the boilers may foam, or how long a pipe line is exposed to cause condensation. If the cut doesn't explain it our catalog will.

GOUBERT MANUFACTURING COMPANY
No. 90 West Street, New York City, N. Y.



McDANIEL STEAM TRAPS

are especially adapted for draining steam separators and high pressure mains. Also good for steam heating. All working parts are attached to the bonnet, and are removable with it. Valve outlets are large, to give rapid discharges of condensation.

Watson Steam Pump Governor

should be used on all steam pumps where a fixed discharge pressure is desired.

The construction permits of easy access to the stuffing box for removing packing, and the spring can be adjusted or entirely removed without interfering with any other part of the valve. Any practical man will readily see its advantages.

All our goods are made in our own factory and tested before shipping. We guarantee them to give perfect satisfaction. Established 1878.

Send for Catalogue.

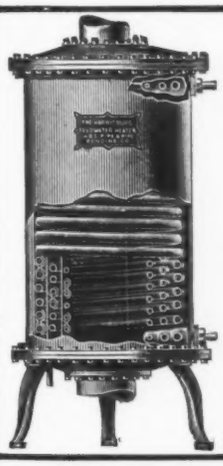
Watson & McDaniel Co.,
148 North 7th Street, Philadelphia, Pa.

The Reilly Multicoil Heater

Used by the U. S. Government because it is the lightest, most efficient, and the best designed feed water heater.

It costs no more than less efficient types. It gives better and longer service than the most expensive. We recommend using a thermometer to prove our guarantees.

THE GRISCOM-SPENCER CO.
90 West Street, New York
STEAM BOILERS — ENGINES — TANKS
THE REILLY GREASE EXTRACTOR AND FEED WATER FILTER



HARRISBURG FEED WATER HEATER

of Pure Seamless Copper Coils

Guaranteed to be the most effective, most durable and cheapest heater manufactured.

COPPER, IRON AND BRASS PIPE

Coils and Bends of any desired shape. Manufacturers of High Grade Wrought Iron Pipe, Black or Galvanized. Write for descriptive catalog.

Manufactured by
The Harrisburg Pipe & Pipe Bending Co.
950 Herr Street, HARRISBURG, PA.

ON GUARD!

The **GEIPEL STEAM TRAP,** being automatic, is ever on the alert, hence no steam can escape

Made In Seven Sizes and for All Pressures.
WRITE FOR CIRCULARS.

JOHN PLATT & COMPANY
97 Cedar Street **NEW YORK**

NO COST

till you are satisfied that the

Patterson-Berryman Feed Water Heater

Will save fuel, boiler repair costs and increase the efficiency of your plant, by eradicating scale forming impurities from your feedwater.

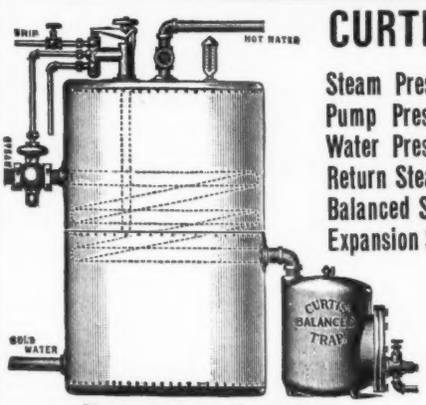
Write!

Frank L. Patterson & Co.
28 Cortlandt Street, New York, U.S.A.

Get The Kitts Catalog It Pays

Steam Traps — Pump Governors
Reducing Valves — Fan Engine Regulators
Safety Water Columns — Damper Regulators
Low Water Alarms — Safety Feed Water
Low Pressure Boiler Feeders — Regulators
Vacuum Pressure Reducing Valves

Kitts Mfg. Co., Oswego, New York



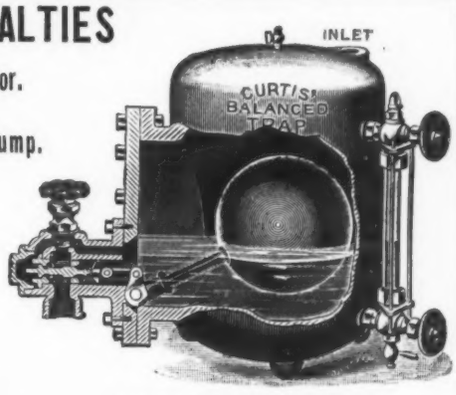
Temperature Regulator.

CURTIS ENGINEERING SPECIALTIES

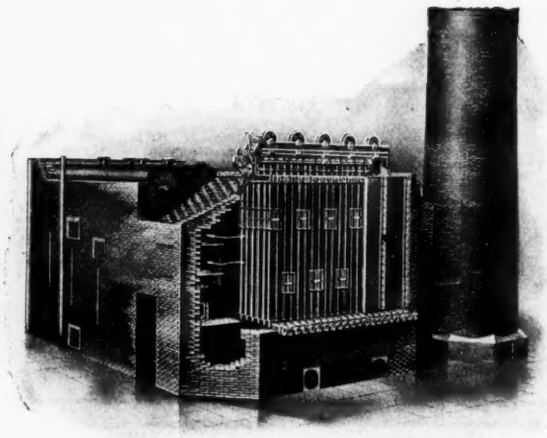
Steam Pressure Regulator.	Temperature Regulator.
Pump Pressure Regulator.	Damper Regulator.
Water Pressure Regulator.	Tank Governor and Pump.
Return Steam Trap.	Cellar Drainer.
Balanced Steam Trap.	Ballcock.
Expansion Steam Trap.	Separator.

Send for catalog.

MANUFACTURED BY
Julian d'Este Company,
24 Canal St., Boston, Mass.



Balanced Steam Trap.



The "Other" Side
OF THE
Economizer Ledger

It is easy to show the benefits arising from the use of an economizer. The coal saving can be figured out definitely in advance and usually amounts in a year to from 25 to 50% or more of the first cost of the machine. The advantages of always having a large body of feed water on hand, of protecting the boilers from scale and cold feed, and of smoothing out fluctuations in the load on the boiler plant are appreciated by steam plant engineers and owners.

However, there is the other side of the ledger, which the economizer manufacturer will put forward or keep back, according to his knowledge and faith in his economizer. Not only are first-class materials and workmanship and the special knowledge and skill which can be acquired only by long experience of importance here, but there are many little details in economizer design which have great influence upon the cost of economizer upkeep, but which are apt to be overlooked by a person who has not had to do with economizers.

Take for instance the top header. The top headers of the Green Fuel Economizer are planed on the sides and set close together. No covering is required over them to keep in the flue gases. A master hand-hole permits of taking out all the other hand-hole plates for access to the tubes without removing the access or branch pipe. Green Top Headers are joined one to another, not by rigid, inflexible joints subject to springing and leaking, but through a branch pipe with flexible, gasketed joints outside of the economizer chamber and removed from the action of the gases.

The Green Bottom Headers are deep but narrow in cross-section, leaving ample room between for soot to fall through, and even for the passage of a man's arm. Like the top headers, they are not joined inflexibly, to be sprung and loosened by unequal settlement, but by gasketed joints outside of the economizer chamber. If leakage occurs, it will be outside of the chamber, where it can do little harm and can be seen at once.

The Green Economizer has heavy, long and perfectly constructed scrapers, substantial scraper-driving mechanism, the best manner of inserting the pipes in the headers, and the best arrangement of the pipes in relation to each other. When you buy a Green Fuel Economizer you buy more than an economizer. You buy the economizer engineering and economizer experience that go with it. Send us information and we will make a preliminary lay-out and estimate. Ask for Book "P 106."

The Green Fuel Economizer Co.
Matteawan, N. Y.

New York City, Boston, Chicago, Atlanta, San Francisco, Los Angeles, Seattle, Salt Lake City, Montreal.

Engineers; Builders of Green's Fuel Economizers, Fans, Blowers and Exhausters, Steam Air Heater Coils, Waste Heat Air Heaters, Mechanical Draft, Heating and Ventilating and Drying Apparatus, Draft Dampers and Engines.

145

NO INSIDE JOINTS STRAIGHT TUBES BACK PRESSURE

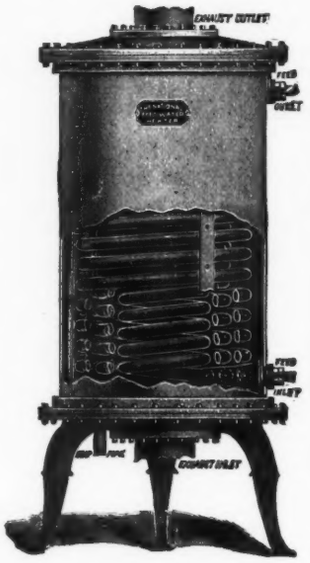
The first cost of a

NATIONAL FEED-WATER HEATER

is practically the only cost and the installation the only attention it requires.

Nothing could be simpler, more effective or more durable in heater construction.

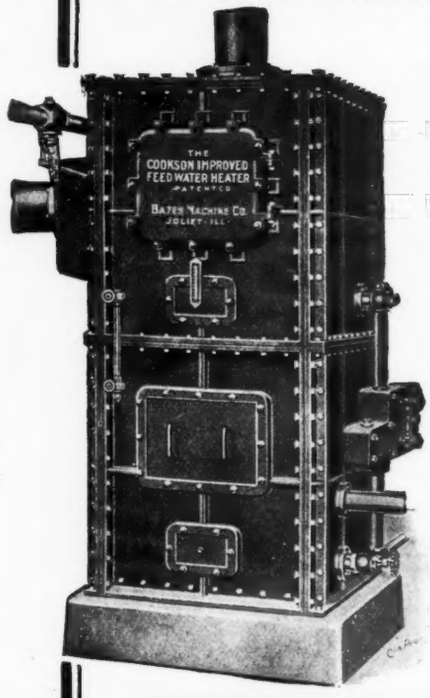
Write for details.



The National Pipe Bending Co.,
175 Lloyd Street, New Haven, Conn.

120 Liberty Street, New York — 54 High Street, Boston, Mass.

COOKSON STANDARD ALL CAST IRON FEED WATER HEATERS



Highest Temperature and Positive Purification of feed water.

Perfect Separation and Removal of Oil.

Automatic Control of Cold Water Supply.

Dry Steam for Heating Purposes.

Finest Grade Special Fittings.

Lime Catching Pans. Especially Adapted for use with Heating Systems, Dryers, Etc.

Write for our new Heater Catalog.

BATES MACHINE COMPANY
Sole Manufacturers **Joliet, Illinois**

An All Around Heater Inside and Out

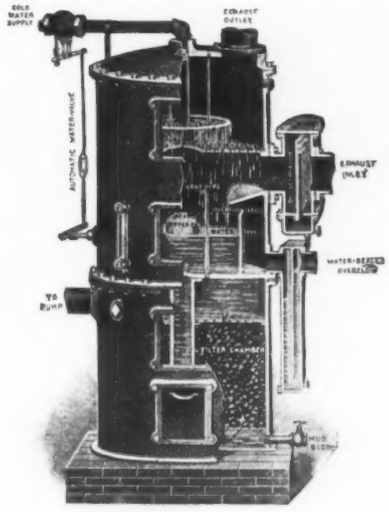
The inside tubes heat the water, the outside shell keeps it hot.

The Baragwanath Steam Jacket Heater

differs essentially from all others in that it presents absolutely no cooling surface. Write for full particulars.

Wm. Baragwanath & Son,
54 West Division Street,
Chicago, Illinois, U. S. A.
Thos. B. Whitted, Piedmont Bldg., Charlotte, N. C., Southeastern Manager

THE WHITLOCK OPEN EXHAUST Feed Water Heater and Purifier



Perfect Oil Separation. Easily Cleaned. The Highest Possible Temperature in the Feed Water.

Manufactured by
THE WHITLOCK COAL PIPE COMPANY
HARTFORD, CONN.
New York Office—Singer Building, 85 Liberty Street.

EXHAUST STEAM

costs money and will repay its cost if you use

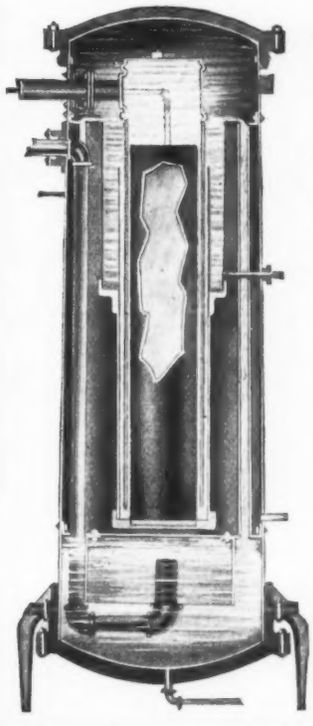
THE OTIS TUBULAR FEED WATER HEATER, OIL SEPARATOR AND PURIFIER

It rarely requires cleaning because the tube plates are set at an angle which prevents sediment from settling among the tubes.

Write for full information.

The Stewart Heater Co.
45 E. Delavan Avenue, Buffalo, N. Y.

HOW LIVE STEAM KILLS SCALE

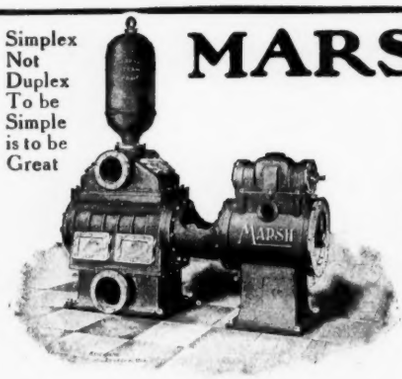


The Eclipse Feed Water Purifier provides even temperature throughout the entire area of the boiler, perfect and even circulation, and the resulting economy in fuel on account of high temperature of the feed water **and elimination of scale.**

Ask for the book.

THE ECLIPSE FEED WATER HEATER AND PURIFIER CO.
OSHKOSH, - WISCONSIN.

Simplex Not Duplex To be Simple is to be Great



MARSH BOILER FEEDERS

are designed for handling hot as well as cold water. They are *at regular prices* fitted with bronze Piston Rods, bronze Water Cylinder Liners held in place by Studs, bronze Valve Seats, Stems, Nuts and glands. THE BEST OF MATERIAL AND THE BEST OF WORKMANSHIP ONLY GO INTO **MARSH PUMPS.**

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American Steam Pump Co., **Battle Creek, Mich.**

Dean Bros. Steam Pump Works

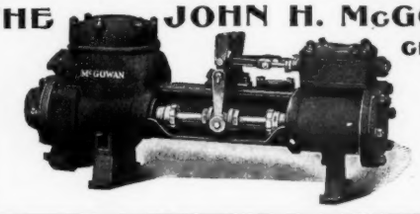
Simple Plunger Pump

INDIANAPOLIS

Simple and Duplex Boiler Feeders. Jet and Surface Condensers. Power and Electric Pumps.

THE JOHN H. McGOWAN CO.

Cincinnati, Ohio



Builders of
PUMPING MACHINERY
Single Duplex and Fly-Wheel Types
Water Works Pumping Engines

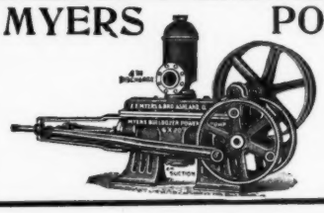
We can elevate or convey your **COAL** a distance of 100 feet for less than **ONE CENT A TON**

in quantities of ONE TON A MINUTE or more.

Catalog Free.

THE C. O. BARTLETT & SNOW COMPANY,
Cleveland Ohio.

MYERS POWER PUMPS



Adapted especially for gas engines, motor and belt powers, in harmony with present requirements.
Catalog sent on request.

F. E. Myers & Bro.,
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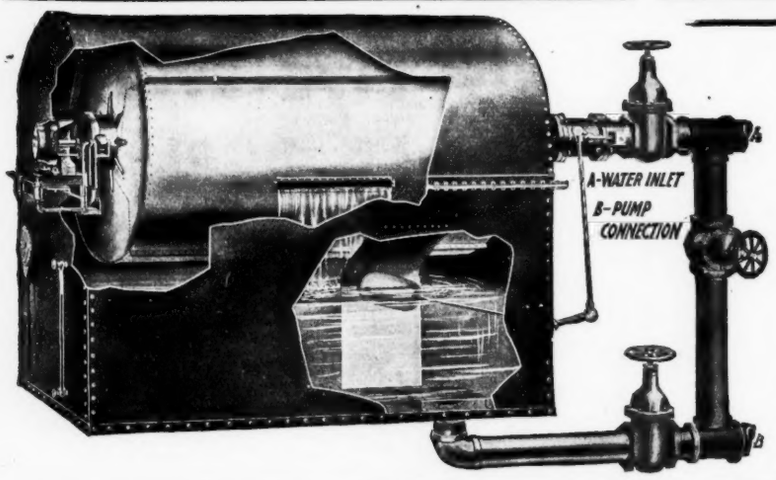

What Are Your Boilers Doing?

Are you getting the best economy?
Is your coal best fitted for your purpose?
Can You Tell Your Evaporation?
A

DETROIT METER

Will Give You a Continuous Record of Your Boiler Feed Water

Built in all sizes for all requirements of power plants, heating companies and for measuring any liquid.

CENTRAL STATION STEAM COMPANY
Detroit, Mich., U. S. A.
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THE RIBLET FEED WATER HEATER

Tubes Fast At One End Only

consequently these heaters are easy to clean and safe from troubles due to expansion and contraction.

A Riblet Heater will save its cost more frequently than any other device you could install in your plant.

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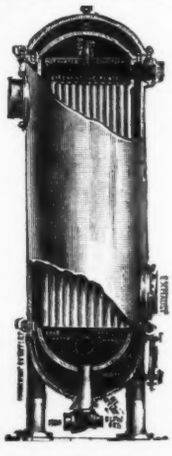
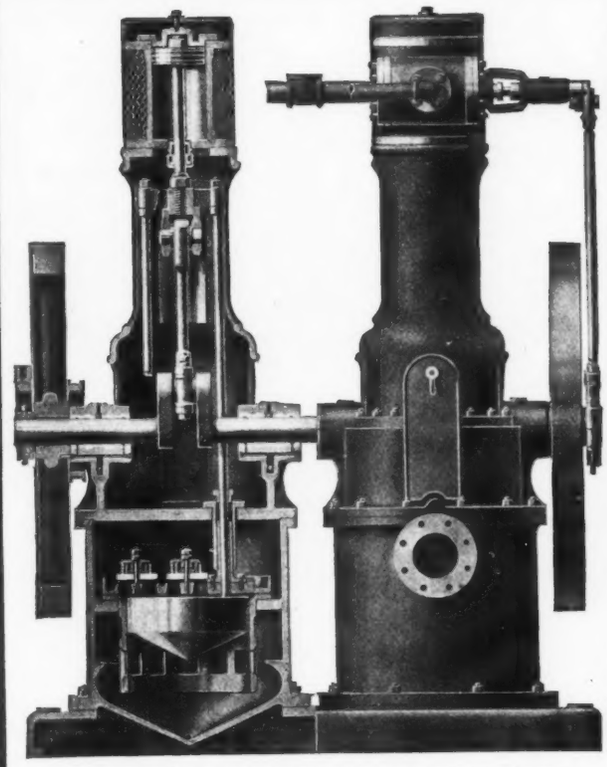
1203 Peach Street, Erie, Penna.





THE VALUE OF SMALL TOP CLEARANCE

The Wheeler-Edwards Air Pump always works in the vertical position and is crank driven, so that the clearance space at the top of the piston can be made very small indeed.

We are further able to reduce the clearance because of the fact that there are no valves on the bucket, so that the smooth surface of the piston can be brought up close to the under surface of the valve deck. If the pump is handling only air, practically the entire charge of compressed air is found out. If it is handling air and water, the water remains below the air, so that if there is enough to fill the clearance space, no air will be left in the pump to re-expand during the return stroke.

In some air pumps, the air must be discharged through valves upon which there is a head of several feet of water. That is, it must be compressed to considerably more than atmospheric pressure before it can get out. Wheeler-Edwards pumps can be arranged to have no head of water upon the valves and the air passes out freely. Another thing, as the pump is crank driven, the piston dwells at the end of the stroke, giving the valves plenty of time to seat themselves before the beginning of the return stroke

All these features are in marked contrast to ordinary pumps in which there are large clearance spaces, a considerable head of water above the valves and a quick jerky motion at the beginning and end of each stroke.

The Wheeler-Edwards pump will show an increased vacuum of ½ to 1 inch over ordinary pumps and will equal or exceed the best rotary dry-vacuum pumps operated in connection with hot-well pumps and air coolers.

Write for Treatise "103 P."

WHEELER

CONDENSER & ENGINEERING CO.

CARTERET, NEW JERSEY.

New York, Cincinnati, Chicago, Denver, Boston, Pittsburg, St. Louis, San Francisco, Atlanta, Houston, St. Paul.

(Builders of Wheeler Surface, Jet and Barometric Condensers, Wheeler-Volz Combined Surface Condensers and Feed Water Heater, Wheeler Feed Water Heaters, Wheeler-Barnard Cooling Towers, Wheeler-Edwards Air Pumps, Wheeler Centrifugal Pumps, Wheeler Rotative Dry Vacuum Pumps and Wheeler Multiple Effect and Evaporating Machinery). 15

WARREN STEAM PUMP CO.,

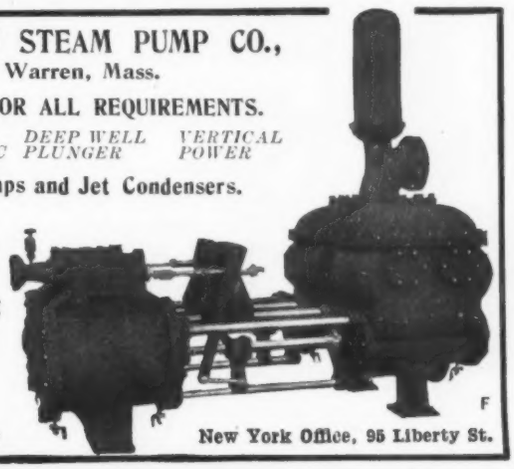
Warren, Mass.

PUMPS FOR ALL REQUIREMENTS.

PISTON HYDRAULIC *DEEP WELL PLUNGER* *VERTICAL POWER*

Air Pumps and Jet Condensers.

Combined Air and Circulating and Marine.

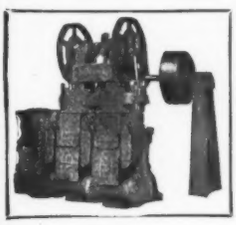


CATALOG ? F

New York Office, 95 Liberty St.

Deming

Ask for Catalogue "G" and treatise "Feeding Boilers."



For any service. **Power**

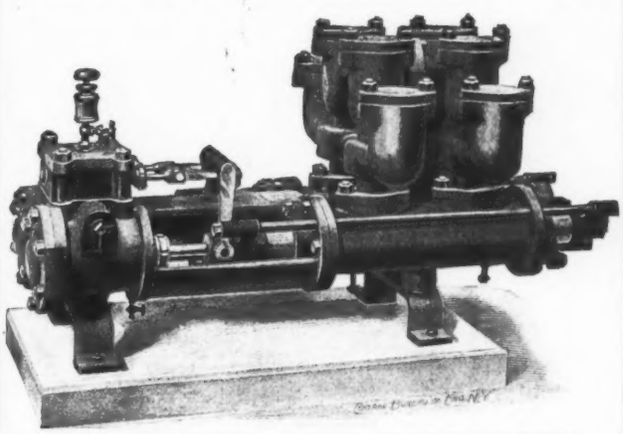
For operation by any power. **Pumps**

The Deming Company

Agencies in Principal Cities **Salem, Ohio**

BLAKE

PUMPING MACHINERY



Duplex Outside End Packed Plunger Pump For 300 Lbs. Maximum Pressure.

We manufacture Steam and Power Pumps for every possible variety of service for use in

POWER STATIONS—REFRIGERATING PLANTS
MARINE INSTALLATIONS—SUGAR HOUSES
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THE GEO. F. BLAKE MANUFACTURING CO.

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Works: East Cambridge, Mass. Branch Offices in all principa cities.

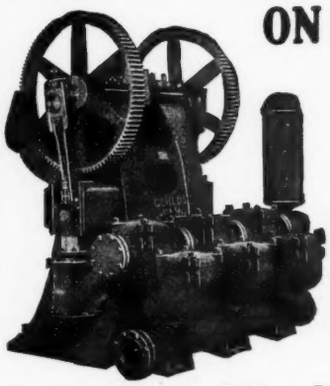
Alberger Condenser Co.

Condensers, Cooling Towers, Vacuum Pumps, Heaters

95 Liberty St. New York

Centrifugal, Volute, and Turbine Pumps

Alberger Pump Co.



ON ACCOUNT

of their extremely low cost of operation and the small amount of attention required

Goulds Efficient Power Pumps

are growing in favor wherever they are installed. Let us send you Catalog of Pumps for every service.

The Goulds Mfg. Co.
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New York. Philadelphia. Pittsburg. St. Louis. New Orleans. Chicago. Los Angeles. San Francisco. Louisville, Ky.

Offsets All Danger Of Bursting Mains

In time and fuel saving alone the **FISHER PUMP GOVERNOR** would repay its cost repeatedly but considering also its saving in repair costs, it is an immensely profitable investment.

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The **FISHER GOVERNOR CO.**
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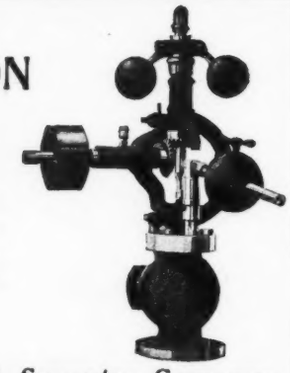
...THIS...

GRAVITY ACTION GOVERNOR

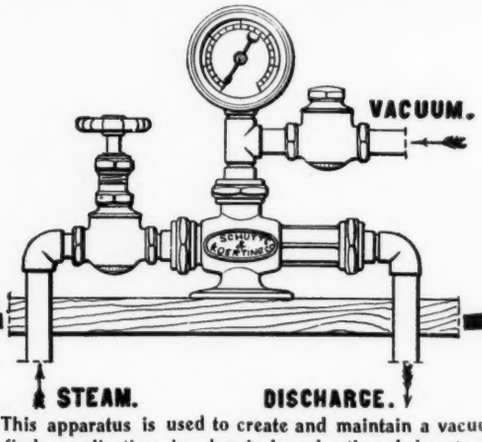
opposes the resistance of a weighted lever to the centrifugal force of the balls. The speed varies with the position of the weight on the lever.

Catalog?



The Gardner Governor & Separator Company,
QUINCY, ILLINOIS.

Laboratory Vacuum Pump



This apparatus is used to create and maintain a vacuum, and finds application in chemical and other Laboratories. With a water pressure of 10 to 20 pounds it will create a vacuum up to 29½ inches mercury.

It is inexpensive and reliable; no moving parts, therefore no wear and tear. We construct these machines for operation by either steam or water pressure, which must be stated on order. Catalog 4-P and prices sent on application.

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Tompson and 12th Sts., Philadelphia

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HYDRAULIC JACKS

Every type of first class thoroughly guaranteed Hydraulic Jacks for all classes of work are manufactured by us.

Over 400 different types and sizes from 2 to 1000 tons capacity.

Each and every tool guaranteed.

Send for Jack Catalog No. 68.

Watson Stillman Co.,

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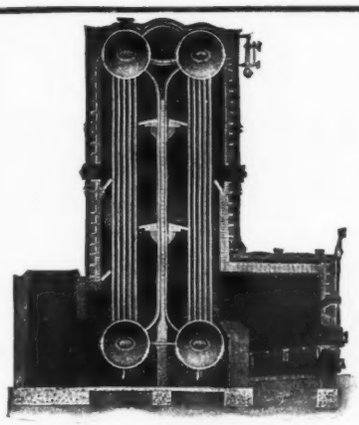

TYPE B

THE RUST
WATER TUBE
BOILER

SAFE, SIMPLE, DURABLE,
ECONOMICAL, ACCESSIBLE

Write for Report of Tests by William Kent.

THE RUST BOILER CO.,
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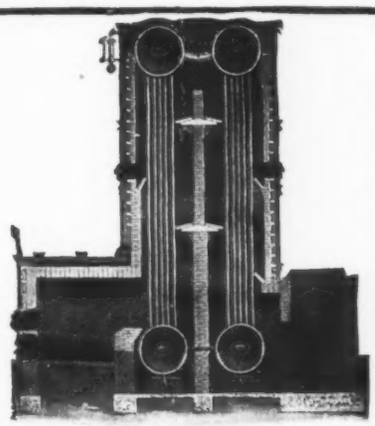
Branch Offices: New York, 50 Church Street; Birmingham, Alabama, First National Bank Building.



TYPE G

PARKER BOILER CO.
WATER TUBE BOILERS—SUPERHEATERS.
PHILADELPHIA, PENNA.
New York—Pittsburg—Chicago—Denver—San Francisco.

Foster Superheaters
Save feed water, condensing water, coal and boiler power.
POWER SPECIALTY CO.,
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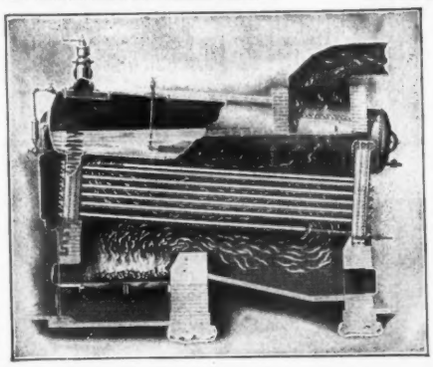
FRANKLIN WATER TUBE BOILER



BUILT BY
FRANKLIN BOILER WORKS CO.,
TROY, N. Y.
SALES OFFICE
39 Cortlandt St.,
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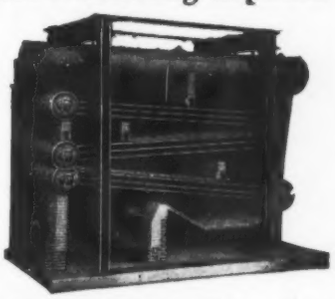
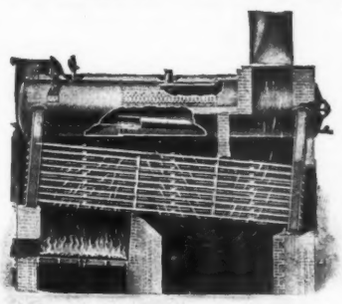
3 Times the Circulating Speed
of any other boiler gives the
VOGT WATER-TUBE BOILER
a freedom from scale formation and a steaming efficiency unapproached by the next best.
Ask for full description.



HENRY VOGT MACHINE CO., Inc.
LOUISVILLE, KENTUCKY

Water Tube Boilers



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E. KEELER CO.
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We are the largest and best manufacturers of storage and pressure tanks in the United States. The story is told. See Book No. 51. Send your specifications.
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—WATER TUBE—
EDGE MOOR IRON CO., Edge Moor, Delaware

Results of 27 years' Boiler Making Experience

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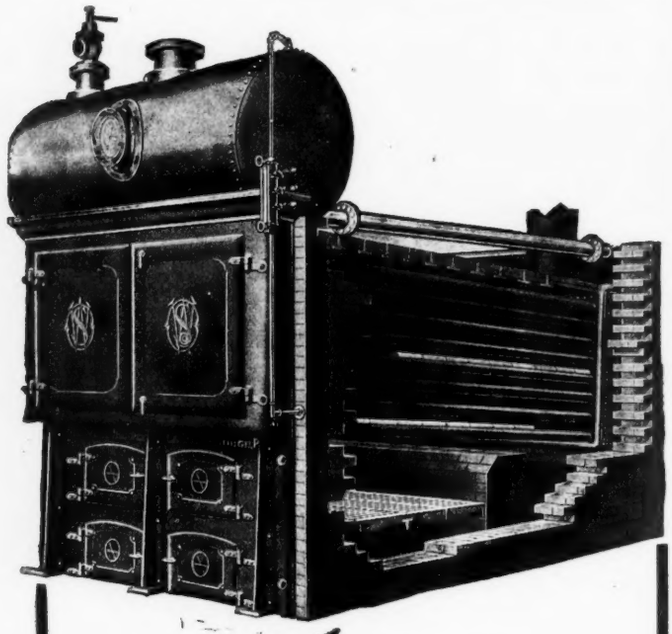

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in any power plant is the boiler system. If you appreciate that fact you will do well to investigate

Our Safety Water Tube Boiler

Built for any pressure from 125 to 300 pounds. Meets all the high duty requirements of modern triple and quadruple expansion and compound engines. Perfect circulation, remarkable economy, and freedom to expand and contract, are features.

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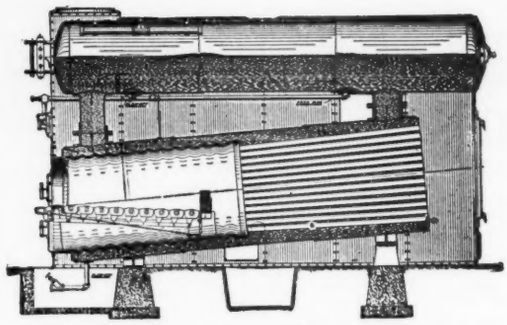
Boiler Works Dep't., - - OSWEGO, N. Y.

Branch Offices—NEW YORK, PHILADELPHIA.

Save Money by Buying a

ROBB-MUMFORD



Internally Fired Boiler

Low first cost—Saving in fuel—Durable, Safe—Built in all sizes from 60 to 250 horsepower.

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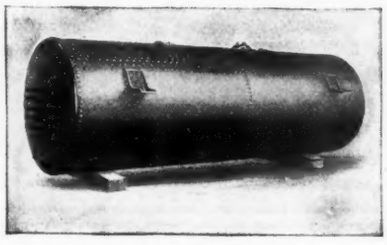
New York Office, 90 West Street. Boston Office, 170 Summer Street.
Built in Canada by Robb Engineering Co., Ltd., Amherst, N. S.



WICKES Horizontal Tubular Steam Boilers

HIGHEST GRADE

THE WICKES BOILER CO.

Also Manufacturers of the Wickes Vertical Water Tube Safety Steam Boilers
Main Office and Works, Saginaw, Mich.

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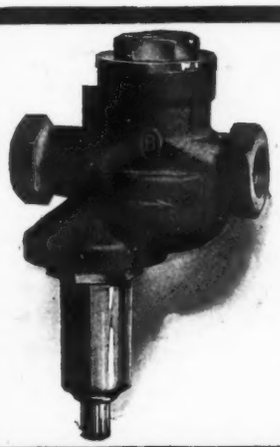
HEINE WATER TUBE BOILERS

AND SUPERHEATERS

All Flange Steel Construction

Send for { Boiler Logic and Superheater Logic

Heine Safety Boiler Co. 421 Olive St., St. Louis, Mo.



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If so, you can end them permanently by installing the

COLLIN STEAM PRESSURE REGULATOR

which insures continuous satisfactory service.
Made in sizes from ¾" to 8" inclusive.
Illustrated Catalogue "B-E" gives full description and list.

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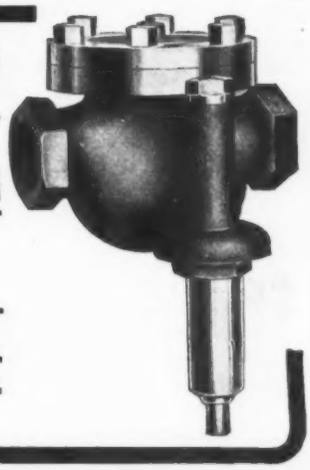

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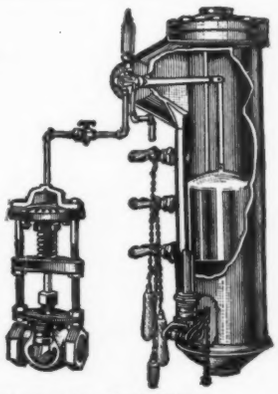
BERRY
Safety
Automatic
Feed Water
REGULATOR
Send for Catalogue
BERRY ENGINEERING COMPANY
Chester, Penn.
Metropolitan Office, 136 Liberty St., New York City.



The Vigilant Feed Water Regulator

for Steam Boilers was the first in the field, and has the longest and best record of any of these devices. *Costs less to operate and maintain.* Constructed on a differem and better principle than any other. Investigate it and the FULTON PUMP GOVERNOR, and send for latest catalog with list of users. A guarantee from a responsible firm with every machine.

THE CHAPLIN-FULTON MFG. CO.,
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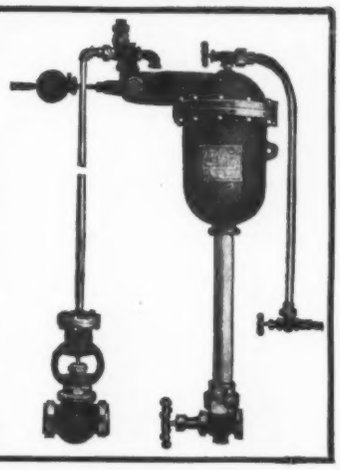
D. W. Patterson, Agent, Harrison Bld., Philadelphia, Pa.



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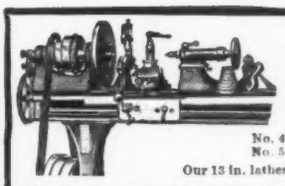

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LATHES
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9 in. to 13 in. Swing.
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Our 13 in. lathes made 5 to 10 feet long. Send for lathe catalog.
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MORRIN CLIMAX BOILERS

They are compact, safe, strong, durable, and very simple in construction. Large heating surface, quick steam generation, great economy, and many other valuable features. Ask for booklet.

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THE BABCOCK & WILCOX COMPANY
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WATER TUBE STEAM BOILERS
STEAM SUPERHEATERS—MECHANICAL STOKERS
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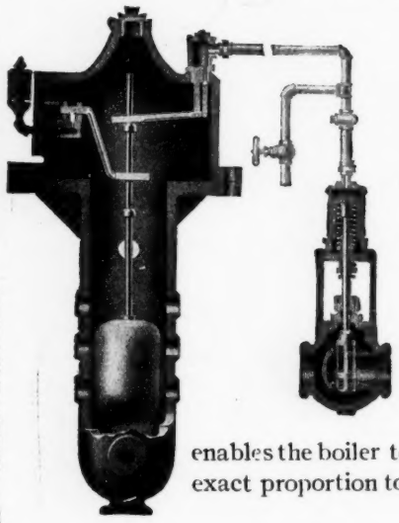
A Perfect Water Level

is only possible where the boiler automatically orders water as it is needed.



The Gould Feed Water Regulator

enables the boiler to obtain water in exact proportion to the evapora'ion.

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The Safety Equipment Manufacturing Co.
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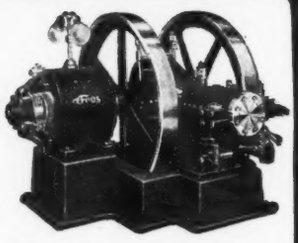
176 E. Lake Street CHICAGO, ILL.

SATISFACTORY SERVICE FROM A GAS ENGINE

Is assured the careful buyer who, after investigating the gas engine proposition thoroughly, invests in a



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The patented wipe spark igniter insures the absence of all ignition troubles, while the accessible design makes it simple for any one to properly adjust the Foos.

In fuel economy The Foos, with a proven thermal efficiency of 28%, ranks second to none. If you want more facts ask for Catalog No. 16.

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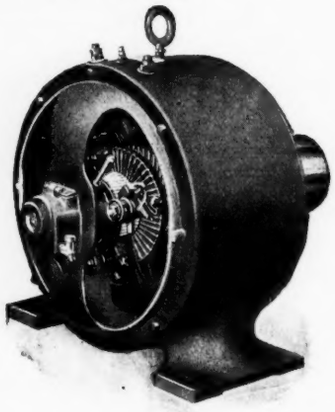
The overload capacity of **C-W** electric generators makes them popular with the engineer. In emergencies they do better than is expected of them. Bulletin 80M describes our D. C. machines.

CROCKER-WHEELER COMPANY
Ampere, N. J.

FORT WAYNE ELECTRIC WORKS
WOOD SYSTEMS

Fort Wayne Motors

will drive your Machines better, easier and cheaper than they can be driven by the old belt-and-line-shaft method. Save at least one-third in power cost. That's worth saving.



Type E F motor without sub-base.

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SALES OFFICES — Main Office: **Fort Wayne, Ind.** — IN MOST LARGE CITIES

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HIGH EFFICIENCY
HIGH POWER FACTOR
COOL RUNNING

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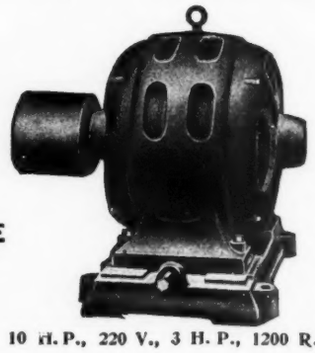


1 TO 75 H. P.

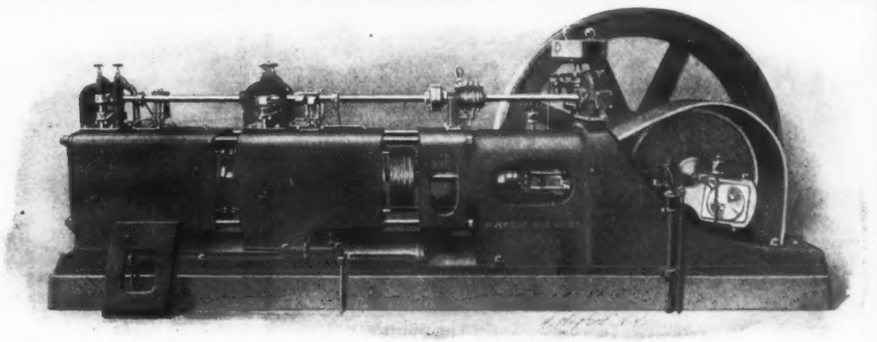
10 H. P., 220 V., 3 H. P., 1200 R. P. M.

Triumph Electric Co.,
Main Office and Works:
CINCINNATI, OHIO
BRANCHES IN ALL LARGE CITIES

Simplicity A Big Feature.

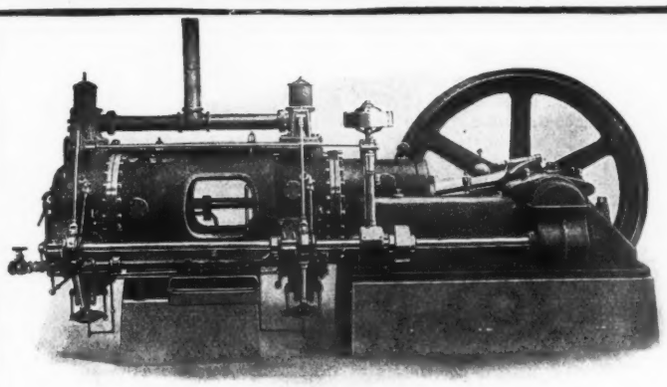
That's ONE REASON why Riverside Gas Engines are so famous. They are as reliable as a steam engine and are built like a "man-of-war."

12 types and 72 sizes to choose from.



Riverside Engine Co.,
Oil City, Pa.

New York City, 50 Church St. Pittsburg, Keenan Bldg. Cleveland, Holbeck Co., 924 Rockefeller Bldg. Fitchburg, Mass., The Brown-Russell Co. Atlanta, The W. E. Austin Co., Candler Bldg. Indianapolis, Mr. F. Louis Egan, 1130 Congress Ave.



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Horizontal and Vertical
Types up to 700 H. P.

NOT AN EXPERIMENT

Economy and Reliability Have Been Demonstrated by Actual Service

FULLY GUARANTEED

For All Street Railway, Electric Light and Power Requirements

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THE CHEAPEST POWER IN THE WORLD

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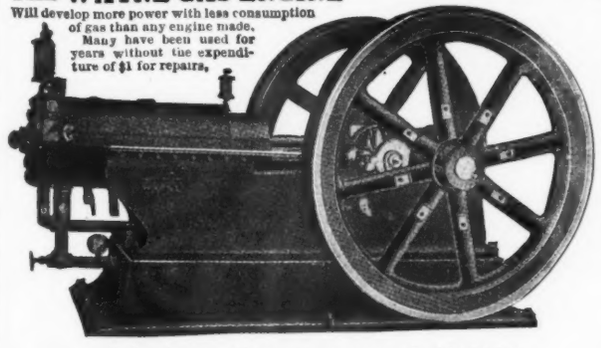
THE WAYNE GAS ENGINE Gas Producers from 35 H. P. up.

Will develop more power with less consumption of gas than any engine made. Many have been used for years without the expenditure of $1 for repairs.



Each engine covered by a positive guarantee. Send for Catalog

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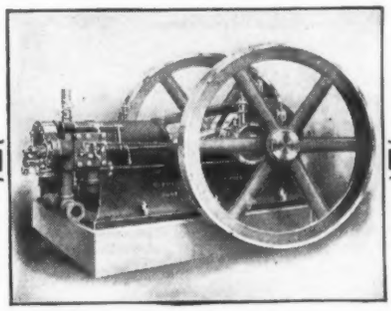
Compact Construction

of the



Du Bois Engines

together with their unusual weight and simplicity render their action most steady, powerful and economic. *Write for catalog.*

DU BOIS IRON WORKS
Established 1877
805 Brady Street DU BOIS, PENNA.

SOUTHWARK FOUNDRY AND MACHINE CO.

Philadelphia, Pa.

SOLE BUILDERS OF THE

PORTER-ALLEN AUTOMATIC STEAM ENGINE

the use of which insures a high economy in steam consumption and a minimum cost of maintenance.

The design is unsurpassed for simplicity and compactness, while the details of valves and gear, bed-plate construction, etc., are greatly liked by all users.

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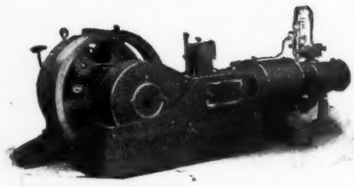

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20 x 42 Allis, Corliss	16 x 32 Buckeye, Automatic
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Also large assortment of Automatic and Throttling Engines of other sizes.

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Heaters, Pumps, Tanks, Saw Mills, Iron Working Tools, etc., etc.

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This cut represents our new set of 20 tools gotten up for use in the engine room. Strictly high-grade tools with all the good points of toolsmithing in their make-up. Conveniently arranged in finished Oak Case and every tool is guaranteed.

No. 20 Set of 20 Tools . . . $4.00.

Book "Engineers' Chums" free. Address Dept. B

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G. W. Hoffman, Sole Prop. 295 E. Wash. St.
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INFALLIBLE
FOR POLISHING GOLD, SILVER, PLATED WARE, NICKEL, TIN, BRASS, COPPER, Etc.
DIRECTIONS:
Take a little of the Polish on a soft cloth, rub the Metal hard and then wipe it off with a dry cloth
Economical
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No Experiment
A Recognized Success

THE ONLY METAL POLISH

that works quick and easy and keeps its lustre. Holds old trade and makes new. IT DOES NOT DETERIORATE. Established 16 years.

3-Ounce Box for 10 cts. 5-Pound Pails, $1.00

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ANY SPEED FROM HIGH TO LOW—TRUMP ALWAYS

Northern motor drives insure a good play at all times—a handful of trump speeds for the operation of pumps, blowers, compressors, conveyors, etc. Means that each machine is driven at the speed best suited to its load for operating conditions. ¶Booklet 8.9 will suggest some means of applying Northern motors in your work to assure maximum results.

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We Manufacture
AN ECONOMICAL AND DURABLE ROTARY ENGINE

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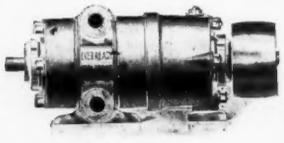
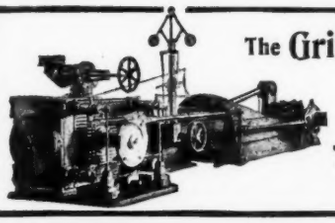


Ball-Cooley Engineering Co.
318 HUDSON ST., NEW YORK CITY and 159 GREEN ST., BOSTON.



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Established 1840
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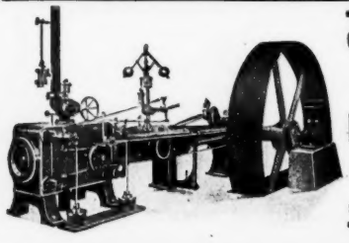
Manufacturers of
The Ohio Corliss Engine and Hoisting Engines



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Refrigerating and Ice Making Machinery

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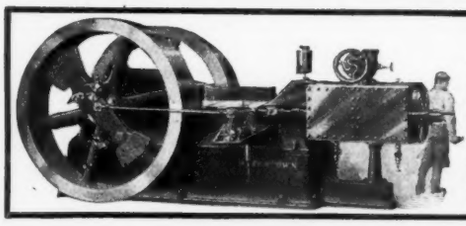

Good Engines

for every power purpose. Ask for Catalog.

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ACCURATE REGULATION FOR ELECTRIC SERVICE-AUTOMATIC CUT-OFF AND RITES FLY-WHEEL GOVERNOR

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One Hour In 8766

is all that is required to keep The Fitchburg Engine steam tight for 25 years.

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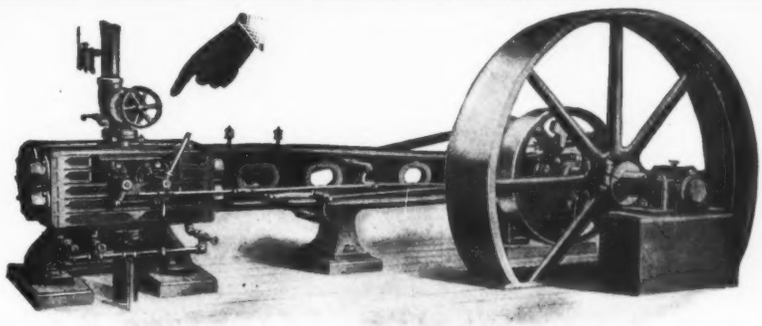

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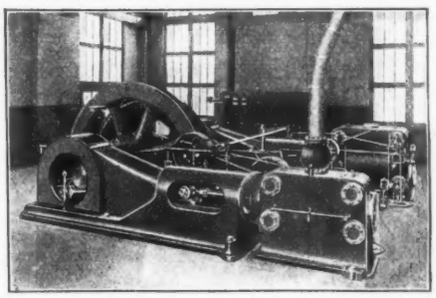
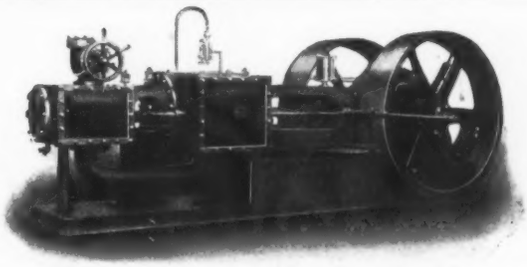


Rice & Sargent Corliss Engines

The illustration shows a 400 K.W. Rice & Sargent engine running 150 R.P.M.
DESIGNED AND BUILT BY

PROVIDENCE ENGINEERING WORKS
Main Office and Works PROVIDENCE, R. I.



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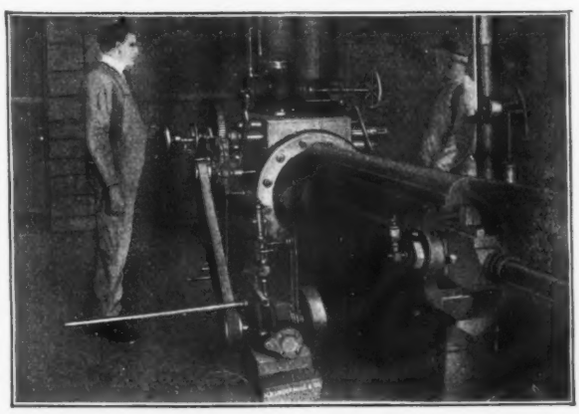
especially designed for high speeds and close governing under severe and rapid fluctuations of load. CATALOG ?

RIDGWAY DYNAMO AND ENGINE COMPANY
Works—Ridgway, Pa., U. S. A.



The Delay Costs More Than the Work

The Underwood method cuts out all of the delay without increasing the cost of the work. Write for further particulars.

AMMONIA CYLINDERS INDICATED

Engineers may have "Booklet P" on request.

H. B. Underwood & Company,
ESTABLISHED 1870
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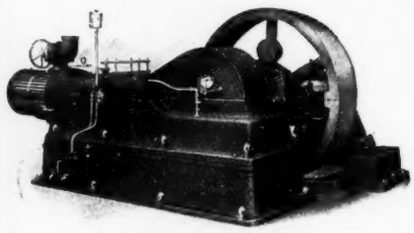
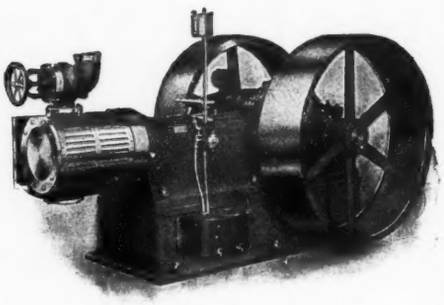


SIDE CRANK TYPE

CENTER CRANK
SIDE CRANK
SINGLE and FOUR VALVE

Skinner Engine Co.,
Erie, Pa.



CENTER CRANK TYPE

BUCKEYE ENGINE COMPANY,
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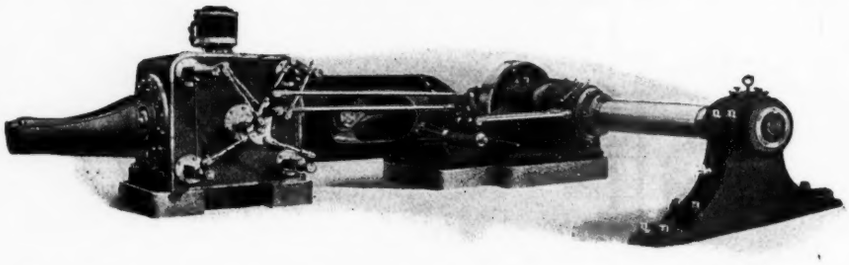
BUILDERS OF HIGH CLASS

STEAM AND GAS ENGINES

HIGH IN DUTY, SUPERIOR IN REGULATION
AND
ABSOLUTELY RELIABLE

CORRESPOND WITH US BEFORE PURCHASING
CATALOGS ON APPLICATION

Long Life Nominal Repairs Perfect Regulation



The Clark Heavy Duty Corliss owes much of the economy of its operation, to its perfectly uniform Valve travel—this is a feature found in no other Corliss engine. Write.

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FINE RESULTS FROM COOPER CORLISS ENGINES

are being secured in all classes of service. We are Engine Builders and also do Complete Steam Plant Engineering.

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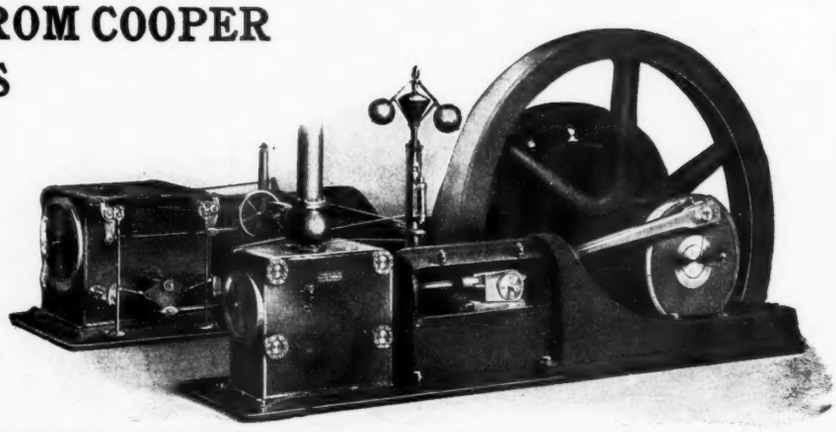
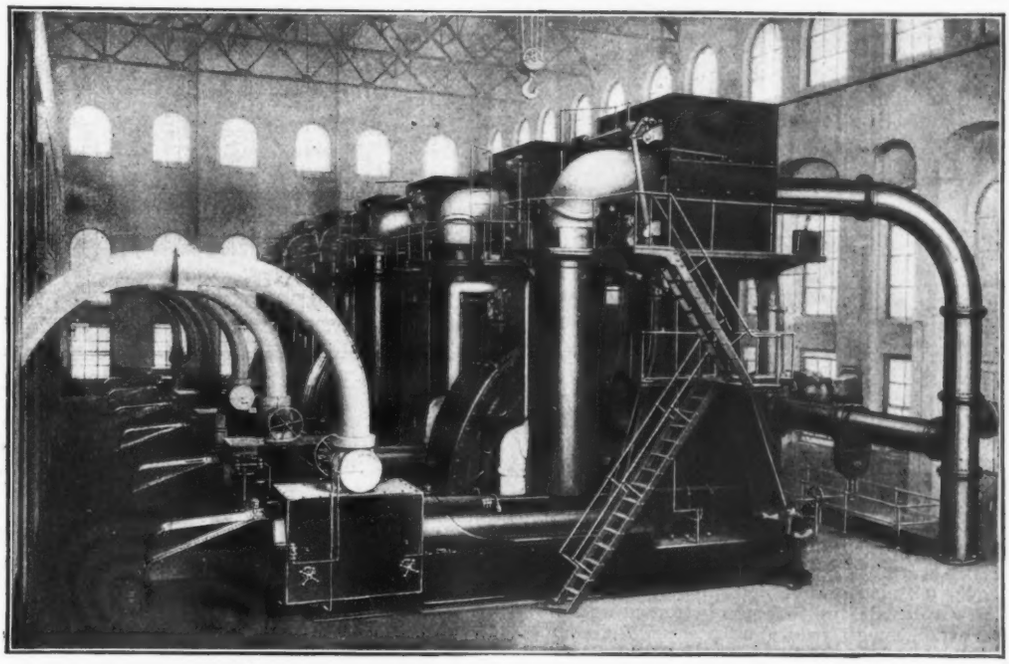


INTERIOR OF THE REDONDO STATION



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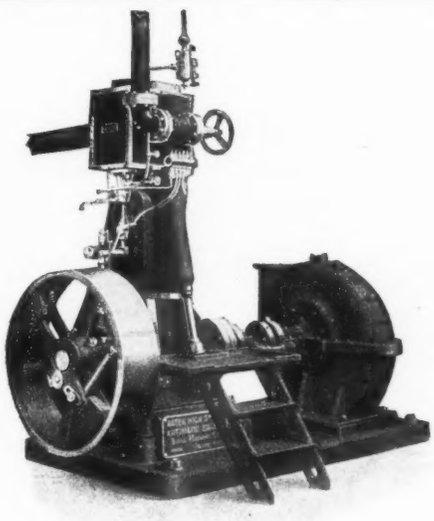

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WATER WORKS, IRRIGATION

and other places where it is desired to move a large volume of water at small expense.

CATALOG FOR THE ASKING.

BATES MACHINE CO., Joliet, Ill.

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ON A MINUTE'S NOTICE

We have for immediate delivery:

One 18-inch by 42-inch girder frame engine, left hand, 90 revolutions, rated at 250 h.p.; wheel 14-ft. diameter by 48-inch face.

One 19-inch by 42-inch girder frame engine, right hand, 100 revolutions, rated at 280 h.p.; wheel 14-ft. diameter by 33-inch face.

The above are **new** engines.

One 14-ft. diameter by 28-inch face pulley, turned for belt. Hub bored 11-inches diameter. Wheel weighs 15,000 pounds.

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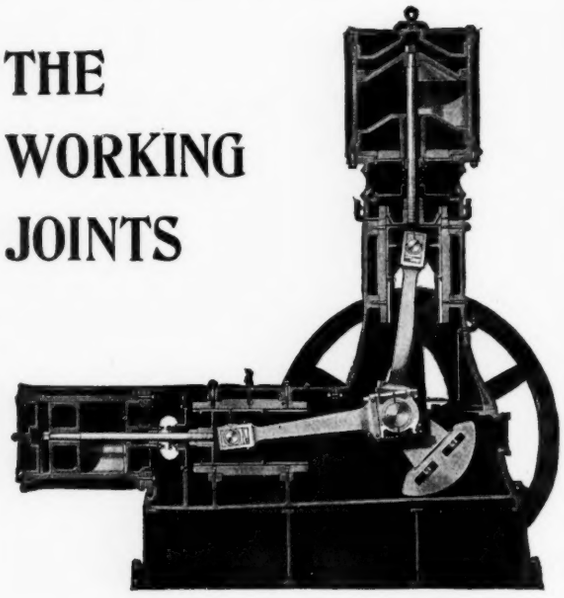
THE WORKING JOINTS



that is, the bearings, are the vital parts of an engine. They are practically the only parts subject to wear and the materials of which they are made, the provision for adjusting them, and the oiling arrangements determine whether the engine will be long-lived and reliable or whether it will soon develop hot bearings, require re-babbitting, etc.

The most important bearings of an engine are those at the two ends of the connecting rods. In the above vertical section of an

AMERICAN=BALL ANGLE COMPOUND ENGINE

you will notice that the crank pin is not overhung. The shaft is therefore better able to withstand bending moments, and to hold the crank pin in line. There is no temptation to use a shortened crank pin. Moreover, as compared with a simple engine of the same capacity, thrusts are divided into two components and the maximum bending moment thereby reduced.

Again, notice the cross-head, it is solid, and has no detachable parts, an important matter in a high speed engine. The guides, instead of being solid with the engine frame casting, are detachable and renewable, in fact, they can be adjusted while the engine is in motion.

The size of these bearings gives a very liberal margin of safety at the usual speeds and an Angle Compound engine can be safely run at much higher speeds than our ratings. All these bearings, including even cross-head and guides of the valve stem, are served by an oiling system, the oil being pumped direct to a storage tank from which it is distributed by sight feed oilers.

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6

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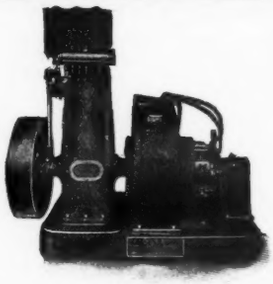

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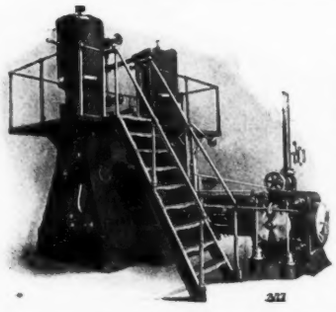

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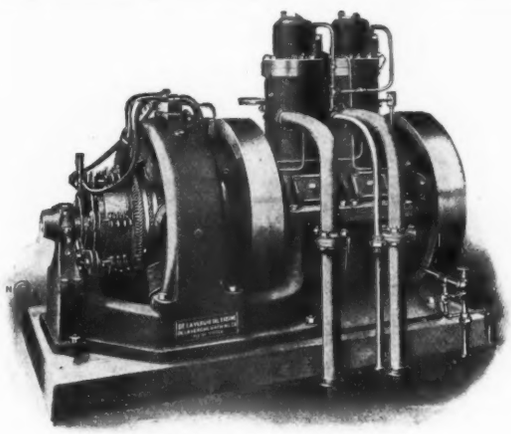

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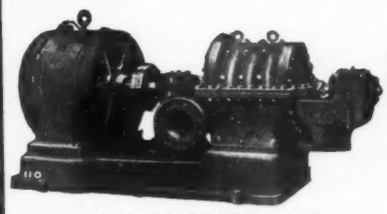

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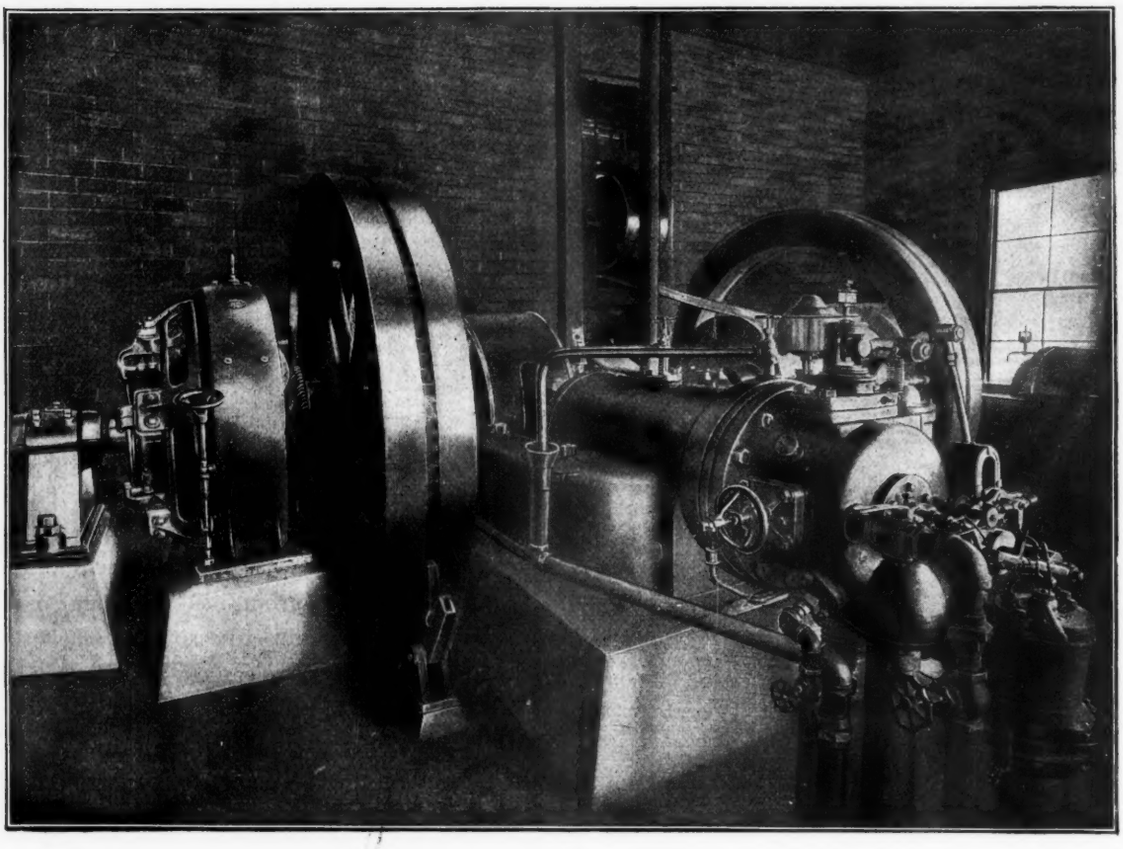

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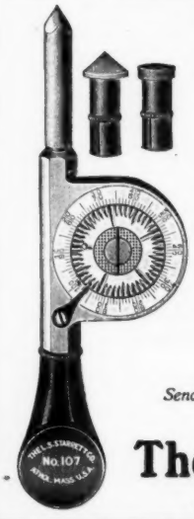

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